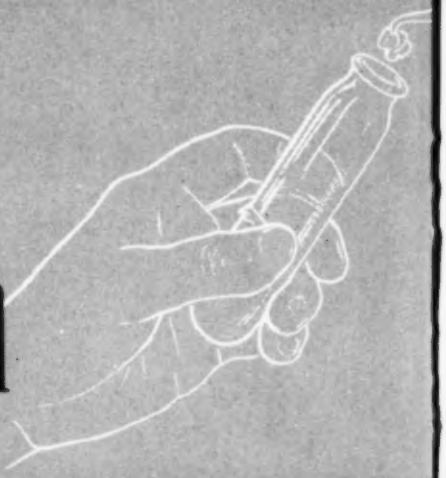
PUBLIC HEALTH REPORTS

In this issue

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Influenza Immunization



PUBLIC HEALTH REPORTS

Volume 72, Number 10

OCTOBER 1957

Published since 1878

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frontispiece

The Public Health Service evaluates vaccines for safety, purity, and potency against influenza. The student inoculated here is participating in a potency study. (See page 861.)

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Published concurrently with this issue:

PUBLIC HEALTH REPORTS

Public Health Reports, published since 1878 under authority of an act of Congress of April 29 of that year, is issued monthly by the Public Health Service pursuant to the following authority of law: United States Code, title 42, sections 241, 245, 247; title 44, section 220. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, August 24, 1957.

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
MARION B. FOLSOM, *Secretary*

PUBLIC HEALTH SERVICE
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Philippine Influenza Epidemic of 1957

MATTHEW TAYBACK, Sc.D., and ARTURO C. REYES, M.D., Dr.P.H.

This paper presents such data as it has been possible to assemble on the commencement of the influenza epidemic in the city of Manila, the time sequence of the outbreak, the nature of the resulting mortality, and an estimation of the attack rates. The information should assist in an appreciation of the epidemiology of Asian influenza, which during the first half of 1957 was reported in epidemic proportions in Hong Kong, Singapore, Taiwan, the Philippines, Japan, Australia, and India.

AN UNUSUAL increase in the incidence of reported cases of influenza in the city of Manila, Philippines, was apparent as early in 1957 as the week ending May 11, the 19th week (see chart). Evidence that influenza was present in epidemic proportions in the western Pacific area immediately prior to this time is available from intelligence reports gathered by the Singapore Epidemiological Intelligence Station. The information is in the files of the Western Pacific office of the World Health Organization. The earliest indication of epidemic influenza appears in the following abstract from a story in the *South China Morning Post*, Hong Kong, April 17, 1957:

EPIDEMIC IN CHINA—Arrivals in Hong Kong yesterday from Central China said that influenza has reached epidemic proportions in Shanghai, Nanking, Kuhan, as well as Peking. Doctors, they added, were working overtime in hospitals and clinics treating patients. They said that as far as they know, no deaths from influenza have been reported. Chinese newspapers said that influenza was also spreading in other parts of China and as far north as Inner Mongolia, as well as southwards in Kwangsi and Kwangtung. Many cases, it was added, had already been reported in Canton.

The following statements in a subsequent report by the Singapore intelligence officer dated May 20, 1957, appear pertinent to the introduction of influenza into the Philippines through Manila.

HONG KONG—Commencement . . . In 2d week of April 1957 rising to epidemic incidence in the 3d and 4th weeks of that month. Number of cases has been falling rapidly since then.

Total numbers affected are not obtainable with any degree of accuracy as the disease has not been notifiable; but as an estimate, not less than 10 percent of the population were affected. Absence of sick staff caused slight curtailment of transport services and some restriction of output from factories. Schools officially remained open.

Fatality rate was negligible.

TAIWAN—At the end of April 1957, many cases with symptoms of influenza appeared in the public hospitals and private clinics in Keelung City. In Taipeh City, cases with symptoms of influenza appeared at the beginning of May.

No fatal cases have been proved.

SINGAPORE—As of May 9, the influenza epidemic has affected about 10 percent of the population.

It is reasonable to suppose that the onset of epidemic influenza in Manila was associated with the presence of this entity in Hong Kong and Taiwan, both of which are in frequent, if not daily, contact through commercial and passenger traffic with Manila. The existence of epidemic influenza in South China was a pos-

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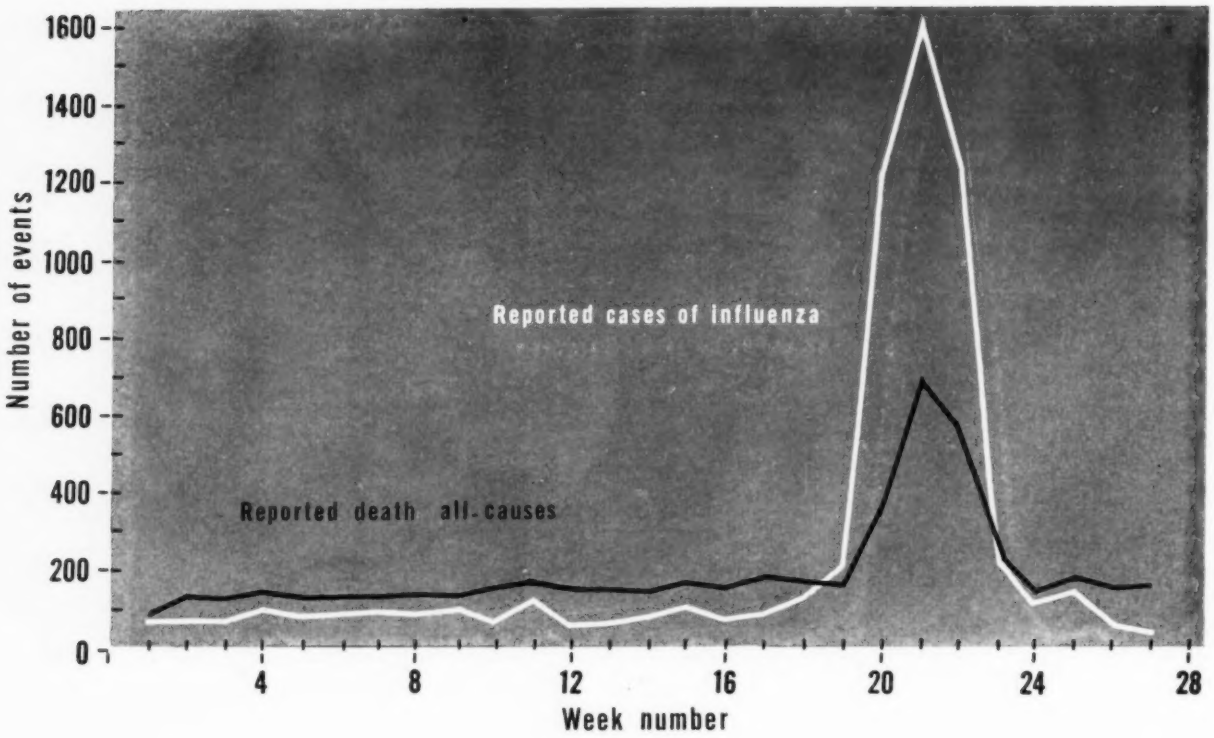
Cases of influenza and deaths from all causes, by week of report, Manila, 1957



sible prelude to its introduction into Hong Kong.

Influenza is endemic in Manila. The weekly reported incidence ranged from 59 to 209 cases during the first half of 1956 and from 55 to 149 cases for the first 18 weeks of 1957 (table 1). In the week ending May 11, 212 cases were reported, a substantial rise from the weekly totals recorded prior to that time. By itself, this rise would have little significance, but in the following week the reported incidence was 1,215. It may be surmised, therefore, that epidemic influenza took hold during the week of May 11. Examination of the chart indicates that the influenza incidence returned to the endemic level during the week ending June 15, the 24th week. Epidemic influenza was present for a period of 5 weeks, with the preponderance of reported cases occurring within a period of 3 weeks.

Extent of Population Affected

The intelligence reports received and issued by the Singapore Epidemiological Intelligence Station were notably deficient in valid estimates of the incidence of influenza during the epidemic intervals. The medical officer of Hong Kong reported that not less than 10 percent of the population was affected. The health authority of Singapore also reported an incidence in the area of about 10 percent. The city health officer of Manila based an estimate of incidence upon the experience of city employees and reached an impression of 20 percent.

Using a form for ascertaining household incidence of influenza during the second quarter of the year, originally proposed by Dr. Jacinto Dizon, chief of the section of epidemiology and vital statistics, Bureau of Health of the Philippines, we obtained an attack rate of 44 percent for members of the 49 households with which students at the Institute of Hygiene, University of the Philippines, were associated (table 2). Study of the factor of residence, rural versus urban, yielded no difference of note. Age variation in attack rates was evident, smaller frequencies being noted at older ages, but the small size and the extraordinary selectiveness of the sample indicated caution in analysis. The magnitude of the attack rate for all ages combined was surprising in view of previous estimates of

Table 1. Reported number of deaths (all causes) and of influenza cases, Manila, 1957 and 1956

Week No.	1957		1956	
	Deaths from all causes	Cases of influenza	Deaths from all causes	Cases of influenza
1	88	80	149	59
2	143	77	111	84
3	136	73	144	99
4	146	101	133	68
5	133	89	130	96
6	134	87	128	79
7	137	97	184	68
8	137	95	139	75
9	139	103	120	121
10	157	79	148	100
11	171	126	164	87
12	152	55	154	131
13	152	60	138	104
14	150	77	159	100
15	169	117	151	126
16	156	81	188	181
17	187	149	200	209
18	167	128	147	109
19	167	212	163	105
20	364	1,215	185	124
21	693	1,621	195	110
22	569	1,244	154	133
23	267	270	163	132
24	139	122	202	125
25	166	161	190	146
26	150	56	205	182
27	162	50	185	114

10 to 20 percent and in view of the high economic standing of the sample.

It was decided, therefore, to select a representative sample of the population in Manila and by household interview to obtain unbiased estimates of influenza attack rates. The existence of an ongoing sample survey program, the Philippine statistical survey of households, provided a frame from which we could choose a stratified systematic sample of households. Of the 159 households selected, 141 (88 percent) were successfully interviewed. Seventeen households could not be located, but substitutions were made for all except one by taking the unit closest to the scheduled household. The following data are based, therefore, on 158 household interviews.

The total number of individuals in the units interviewed was 1,144, an average of 7.2 per household. This is about the same size family as found in the student household survey (8.3) but, of course, much larger than the average in the United States and in most Western European countries. The distribution of the sample by age and the attack rates for influenza are shown in table 3. For all age groups, 70 percent of the individuals for whom a history was obtained were attacked by influenza. The attack rates do not vary significantly within the age range 1–14 years. However, there is evidence of decline in attack rates with age for individuals 15 years and older, although the attack rate for persons 45 years of age and over still exceeds 50 percent.

No noteworthy sex differences in attack rates were observed. The age trends noted above

Table 2. Influenza experience of 49 households, reported by students of the Institute of Hygiene, University of the Philippines, April–June 1957

Age of household members (years)	Number persons at risk	Number attacked	Percent attacked
	Total		
All ages	411	180	44
Under 1	15	6	40
1–4	34	20	59
5–9	40	21	53
10–14	55	26	47
15–24	101	44	44
25–44	114	44	39
45 and over	52	19	37
	Metropolitan Manila		
All ages	112	47	42
Under 1	3	0	55
1–4	8	6	
5–9	9	5	41
10–14	8	2	
15–24	28	15	54
25–44	41	14	34
45 and over	15	5	33
	Rest of Philippines		
All ages	299	133	44
Under 1	12	6	50
1–4	26	14	54
5–9	31	16	52
10–14	47	24	51
15–24	73	29	40
25–44	73	30	41
45 and over	37	14	38

Table 3. Influenza experience reported by a sample of 158 households in Manila, April–June 1957

Age of household members (years)	Number persons at risk	Number attacked	Percent attacked
All ages	1,144	796	70
Under 1	32	19	59
1–4	133	104	78
5–9	154	116	75
10–14	130	102	78
15–24	279	204	73
25–44	289	184	64
45 and over	127	67	53

prevailed among both sexes. A question of some importance is whether the proportion of the population affected was influenced by its density. We have found it possible to classify the sample households according to the average density reported for the area in which they were located. Three categories were formed: 50 or more inhabitants per square kilometer, 30–49 inhabitants, and less than 30. No significant difference in attack rates was found.

It is clear that the high attack rates reported for the small group of student households did not exaggerate the extent to which epidemic influenza affected the population of Manila, nor did it improperly indicate the general age trend in the attack experience.

Excess Mortality From All Causes

The severity of an influenza epidemic can be measured by the percentage of individuals who require medical attention, the number of days lost from work, and probably by other indexes. However, there can be little question that the statistics relating to mortality provide a rational means of assessing the severity of the clinical entity which we call Asian influenza.

In Manila, all deaths occurring within the city are registered with the city health department. Deaths among nonresidents are not included in the monthly detailed mortality statistics. It is generally agreed by vital statisticians who have studied the registration system in Manila that registration of deaths is substantially complete. The effect of acute epidemic respiratory disease in terms of death is best measured by a consideration of the excess mortality from all causes which occurs simultaneously with the epidemic rather than in terms of deaths ascribed only to influenza or bronchopneumonia. The reason is that the extent of mortality from tuberculosis and cardiovascular disease can be markedly affected by the presence of influenza.

In table 4 the number of resident deaths for Manila is given by age group and by month for the first half of 1956 and of 1957. The number of deaths from all causes for all ages was very similar in 1956 and 1957 except in May, the peak month of reported influenza cases. In table 5, the number of deaths for each age group is shown for the first 4 months of 1957 and of 1956. The correspondence of the figures for the 2 years is remarkable. It is reasonable to expect that, in the absence of unusual circumstances, the number of deaths from all causes and their distribution by age would

Table 4. Number of deaths, by age and month of occurrence, Manila, 1957 and 1956

Age (years)	January		February		March		April		May		June	
	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957	1956
All ages	616	600	544	606	685	636	715	737	1,850	761	782	808
0–1	234	200	201	221	253	241	274	277	519	277	241	301
1–4	66	77	92	81	100	82	123	116	444	122	144	153
5–9	12	14	11	25	25	23	25	29	154	20	13	23
10–14	5	13	6	6	3	7	11	8	30	11	10	5
15–24	28	28	34	24	22	20	19	31	68	33	46	32
25–44	71	78	50	73	73	68	73	73	184	84	105	78
45–64	96	93	63	76	97	107	83	89	193	97	113	102
65 and over	104	97	87	100	112	88	107	114	258	117	110	114

Table 5. Recorded mortality from all causes, Manila, January–May, 1957 and 1956

Age (years)	January–April		May		1957/1956	Percent of population [1]	Excess mortality	Excess mortality percent of population	Excess mortality per 100,000 estimated population [2]
	1957	1956	1957	1956					
All ages	2,560	2,579	1,850	761	2.4	100.0	1,089	10.9	83.8
0–1	962	939	519	277	1.9	3.9	242	62.1	477.3
1–4	381	356	444	122	3.6	13.0	322	24.8	190.5
5–9	73	91	154	20	7.7	15.0	134	8.9	68.7
10–14	25	34	30	11	2.7	11.3	19	1.7	12.9
15–24	103	103	68	33	2.1	21.3	35	1.6	12.6
25–44	267	292	184	84	2.2	22.7	100	4.4	33.9
45–64	339	365	193	97	2.0	9.9	96	9.7	74.6
65 and over	410	399	258	117	2.2	2.9	141	48.6	374.0

[1] The percentage distribution of population for Manila is assumed to be equivalent to that given for the urban area as reported by the Philippine Statistical Survey of Households, series No. 2, vol. 1, Demographic and Socio-Economic Data.

[2] Population estimates for Manila are extremely difficult to judge with respect to reliability. An estimate by the Bureau of Health for July 1, 1955, was 1,250,000. The annual natural increase is approximately 35,000. The population used here was 1,300,000.

have been about the same in May 1957 as in May 1956. The actual number of deaths during these two months, however, was very different. For all ages combined, the mortality from all causes in May 1957 was more than twice (2.4) what would have been expected from the 1956 experience. The ratio varies with age, the greatest difference occurring among children 5–9 years of age. It should be added that these ratios represent an approximation to the rate of increase in the age-specific mortality rates.

Another way of looking at the data would be to consider the manner in which the various age groups contributed to the excess mortality. Since the intervals covered by the several age groups vary in size and include an unequal proportion of the population, the excess mortality (May 1957 minus May 1956) was related to the percentage of the population to obtain the index "excess mortality percent of population" (table 5). This index was selected because recent information of reasonable precision was available with respect to the percentage distribution of the population by age. For those who prefer to express this index per 100,000 population, an attempt was made to obtain such indexes by age, and these also are shown in the table. These figures may be interpreted as follows. For all ages an excess of 83.8 deaths from all causes per 100,000 population occurred during the epidemic of influenza in May. This rate of excess mortality varies from peaks of 477.3 among infants and 374 among persons 65 years of age and over to minimums of 12.9 and 12.6 for age groups 10–14 and 15–24.

A question which may arise is whether the excess mortality found in Manila in association with epidemic influenza of the Asian strain of virus was unique and peculiar to this city. The reports from Hong Kong, Singapore, and Taiwan indicated that the disease was mild and that fatalities were rare.

We have taken advantage of some papers on file in the Western Pacific office of the World Health Organization to explore this issue a bit further. In table 6 the trend in deaths from all causes and from tuberculosis is shown for Hong Kong for the first 5 months of 1957. During

Table 6. Average weekly number of deaths from all causes and from tuberculosis, Hong Kong, 1957

Period	All causes	Tuberculosis
Dec. 30, 1956–Jan. 26, 1957	338	47
Jan. 27–Feb. 23	466	63
Feb. 24–Mar. 30	394	57
Mar. 31–Apr. 6	352	61
Apr. 7–13	370	45
Apr. 14–20	543	82
Apr. 21–27	681	112
Apr. 28–May 4	506	85
May 5–11	454	79
May 12–18	382	61
May 19–25	387	73
May 26–June 1	361	54

Table 7. Average weekly number of deaths from influenza and pneumonia, Singapore, 1957

Period	Influenza and pneumonia	Influenza	Pneumonia
Dec. 30, 1956–Jan. 26, 1957	14		14
Jan. 27–Feb. 23	12		12
Feb. 24–Mar. 30	14	1	13
Mar. 31–Apr. 27	16		16
Apr. 28–May 4	17	1	16
May 5–11	45	8	37
May 12–18	73	12	61
May 19–25	98	24	74
May 26–June 1	39	8	31

the 3-week period April 14–May 4, the weekly totals of deaths from all causes and from tuberculosis were clearly in excess of the trend prior and subsequent to this period. Furthermore, this period exactly coincides with the reported time of the epidemic of influenza in Hong Kong. Similar data on deaths from influenza and bronchopneumonia could not be found.

For Singapore weekly reports of the city health office gave the number of deaths from influenza and pneumonia, but the number of deaths from all causes was not available. It will be seen from table 7 that excess mortality from influenza and pneumonia combined is unquestionable during the period May 5–June 1, which is consistent with the reported outbreak of epidemic influenza in Singapore.

Certainly a more detailed analysis of mortality data from Hong Kong and Singapore would be helpful, but the excess mortality described earlier in connection with the influenza epidemic in Manila cannot be considered an experience peculiar to this city, nor should broad reports of "no fatalities" be accepted without careful attention to total mortality.

Summary

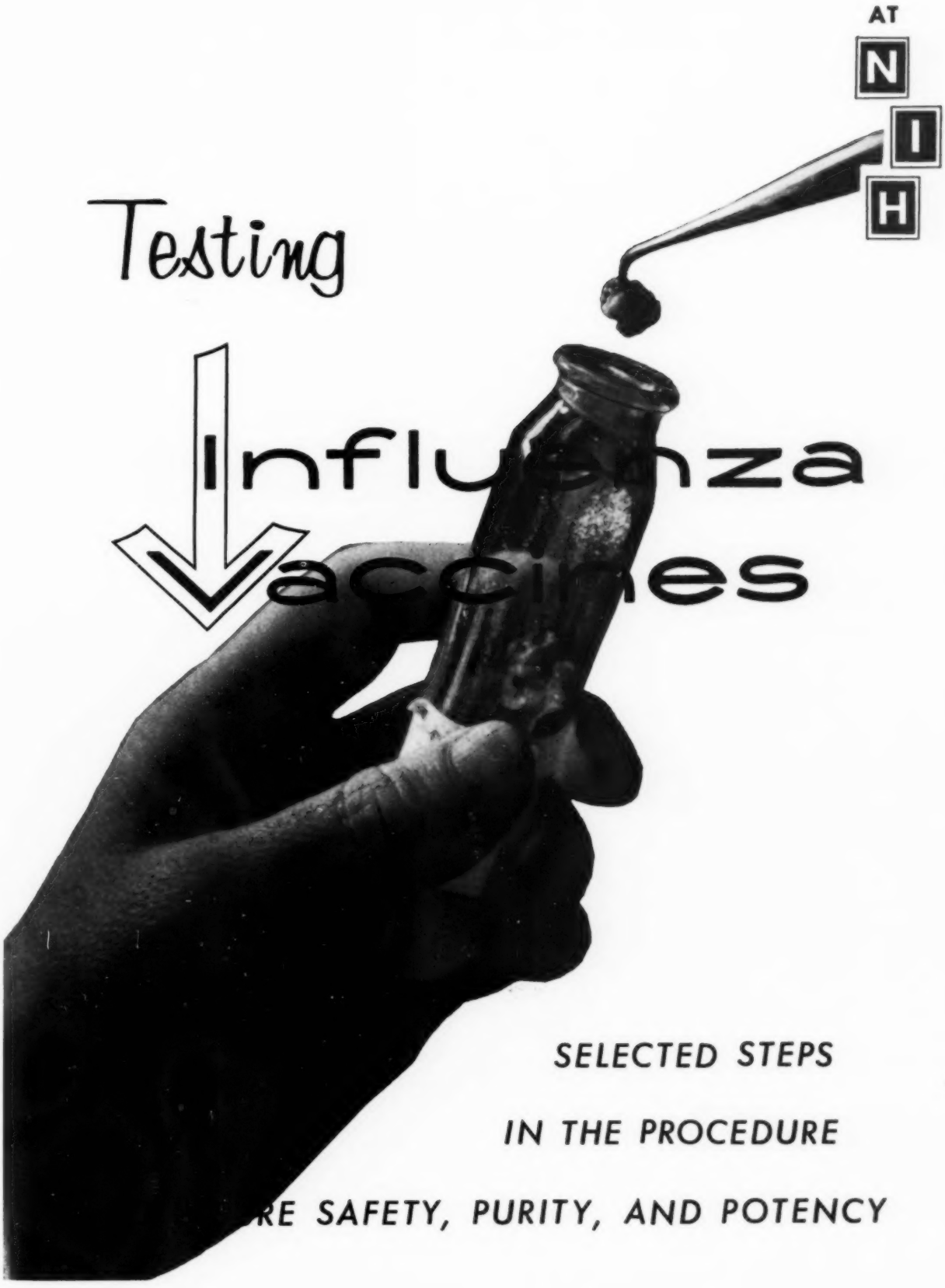
During the week ending May 11, 1957, the reported cases of influenza in Manila, Philippines, gave evidence of the existence of an abnormal incidence of this disease. In the 4 weeks which followed, weekly reported totals were markedly in excess of the endemic levels customarily recorded.

Epidemiological intelligence of the Singapore office of the World Health Organization indicates that several weeks prior to the occurrence of epidemic influenza in Manila, outbreaks of influenza had occurred in China, Hong Kong, and Taiwan. It seems probable that epidemic influenza was introduced into Manila from Hong Kong or Taiwan, or both.

The percentage of the population attacked was determined by means of a household survey of a representative sample of households in Manila. For all ages combined, the attack rate was 70 percent. Maximum attack rates were noted in the age range 1–14 years, with evidence of a decline with increase in age for those 15 years of age and over. However, no age group experienced an attack rate of less than 50 percent. Sex differences were not found, nor was there evidence of variation of attack rates with population density.

Excess mortality was unquestionably attributable to the epidemic. One impression is that as an immediate consequence of the epidemic there was an excess of 84 deaths per 100,000 population, a ratio which varied from maximums of 477 for infants under 1 year of age and 374 for persons 65 years and over to a minimum of 13 for age groups 10–14 and 15–24.

The full impact of an influenza epidemic should be assessed in terms of mortality from all causes rather than in deaths specifically ascribed to influenza.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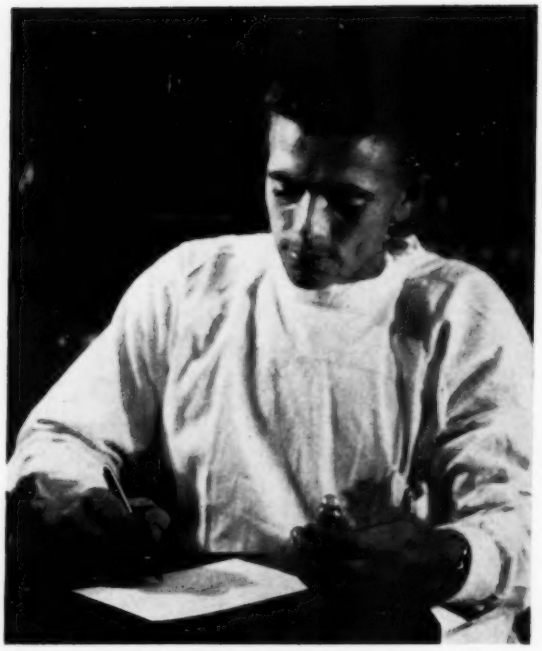
Testing
Influenza
Vaccines
SELECTED STEPS
IN THE PROCEDURE
RE SAFETY, PURITY, AND POTENCY

Vaccine Testing Procedures For Asian Strain Influenza

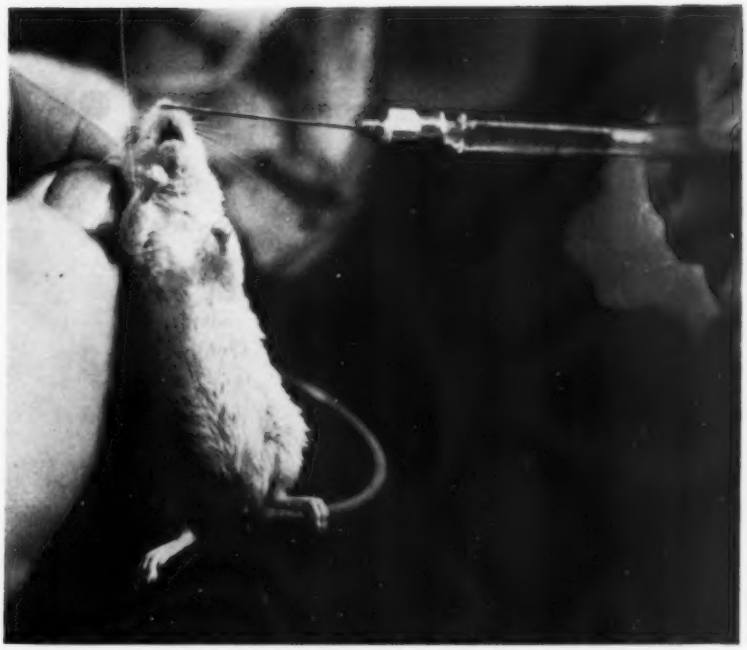
Commercially produced influenza vaccine prepared from the Asian strain virus is tested by the Public Health Service to determine conformance with prescribed standards. Scientists at the Division of Biologics Standards, National Institutes of Health, test samples from each manufacturer to insure safety, purity, and potency of the vaccine. The first lots of the new vaccine were released for use on August 12, 1957, 2½ months after 6 licensed vaccine manufacturers were sent isolations of the Asian strain virus. Some of the procedures used in testing these lots are illustrated here. (*Material presented by the Division of Biologics Standards and the Division of Research Services.*)



Sample of vaccine is logged in. After it is unpacked, the manufacturer's name, vaccine lot number, and other information are recorded, and testing proceeds.

In an early step of potency tests, various dilutions of the vaccine are made. Ratios of vaccine to saline solutions are indicated on the top of each of the containers.

Mice are immunized with vaccine dilutions. Two weeks later, their blood serum is tested for antibodies.



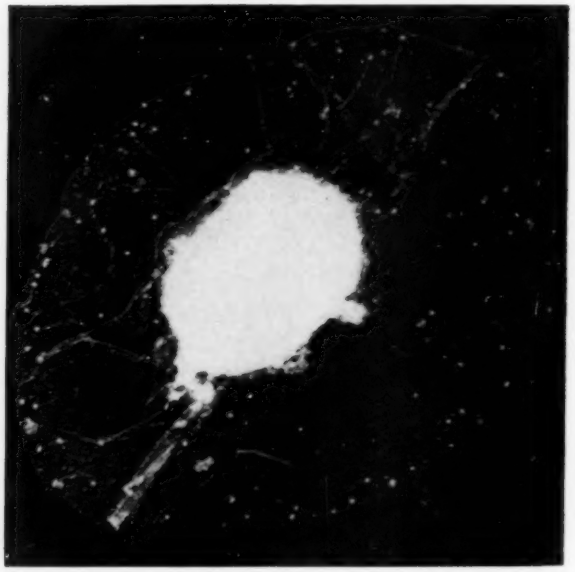
Mouse receives intranasal drops containing influenza virus and antiserum. A 10-day survival indicates that the antiserum is effective and that the vaccine used in its production meets potency requirements.

Lungs of a mouse infected with influenza virus are dropped into a test tube containing alundum, a sandlike substance, to be ground for preparation of a virus suspension used in tests.

Eggs are injected with influenza virus. This is the first step in preparing larger amounts of virus suspensions to be used in various laboratory tests.

Extra-embryonic fluid containing influenza virus is withdrawn from a hen's egg for study. Ultraviolet light prevents contamination with other viruses or bacteria.

Blood withdrawn from a chicken immunized against influenza is used to prepare serum. The serum serves in a variety of tests concerned with control of the vaccine.



Electron micrograph of a red blood cell (greatly magnified) of a chicken with influenza virus. Small woolly spots around the nontransparent nucleus are the virus.

Biological Warfare and Its Defense

LeROY D. FOTHERGILL, M.D.

SINCE any enemy nation might be expected to use all the weapons in its arsenal, it would follow that it would give serious consideration to biological warfare. Because of this possibility it is incumbent upon each of us to become fully acquainted with the nature of biological warfare.

What BW Is

By way of definition, biological warfare is the intentional use of living micro-organisms or their toxic products for the purpose of destroying or reducing the military effectiveness of man. Man may also be injured secondarily by damage to his food crops or domestic animals. The military objective, of course, is to reduce the will or capability to wage war.

It has sometimes been said that BW is public health practice and procedure in reverse. This is an erroneous conception. BW is the deliberate use of natural disease agents whose inherent potential has been exploited by scientific research and development resulting in the production of BW weapons systems.

Military campaigns and troop concentrations have always provided a fertile field for naturally occurring epidemic disease. Infectious disease has often been the critical factor in the outcome of a military campaign.

Bubonic plague was said to have stopped the Crusaders at the very gates of Jerusalem. Dysentery probably caused more casualties in Napoleon's Grand Army than enemy firearms. Typhoid fever and dysentery played no favorites among the opposing forces in the Civil War, the Boer War, and the Spanish-American War. The new science of bacteriology was in its infancy around 1900. Even during World War I, infectious disease was a controlling factor in some campaigns. It is quite clear that typhus fever prevented the Germans from carrying through their Balkan campaign.

In spite of all our modern sanitation and preventive medicine, infectious disease contributed a large share to the cost and difficulty in World War II. Malaria ranked high as an enemy, both in the Mediterranean and in the Southwest Pacific, and scrub typhus caused some 7,000 casualties in the latter area. And finally, it seems almost yesterday that enteric infections, Japanese B encephalitis, and hemorrhagic fever were bedeviling us in the Korean conflict.

In the past, a number of crude, unscientific, and purely local efforts were made to utilize infectious disease for military purposes. Alexander attempted such exploitation by catapulting the bodies of dead men and animals over the walls of besieged cities. It is reported that smallpox was started successfully among the American Indians during the French and Indian War by distributing blankets contaminated with purulent smallpox material. In World War I the Germans infected with glanders horses that were consigned from this country to the Roumanian cavalry. During World War II a number of units of the German Occupation Forces, particularly in Eastern Europe, were said to have been the target of local sabotage efforts with bacteriological agents.

Dr. Fothergill, scientific adviser to the Chemical Corps, Fort Detrick, Md., delivered this paper at a joint meeting of the Nevada State Medical Association and the Reno Surgical Society, at Reno, August 1956.

All of these efforts were, of course, small, local, makeshift, and unorganized with respect to centralized control and direction. It was not until early in World War II that an officially planned program was devoted to research and development in biological warfare. This has continued to the present time as a recognized activity of the Department of Defense. Responsibility for carrying out a program was delegated to the Department of the Army which, in turn, assigned the operational responsibility to the Army Chemical Corps. The major portion of the research and development is conducted at Fort Detrick in Frederick, Md. Close liaison is maintained with other Federal agencies having defensive responsibilities, including the Federal Civil Defense Administration, the Public Health Service, the Food and Drug Administration, and the Department of Agriculture. That a program of research and development continues in permanent facilities constructed for the purpose can be considered as recognition of the potential of the weapon and thus of the defensive problems which we must be prepared to meet.

Effective Agents

Biological warfare is considered to be primarily a strategic weapon which makes it a particular defensive problem for civilian population centers. The major reason for this is that it has no quick-kill effect. The incubation period of infectious disease plus a variable period of illness even before a lethal effect make this weapon unsuitable for hand-to-hand encounter. A man can be an effective fighting machine throughout the incubation period of most infectious diseases. Hence, an enemy would probably consider this weapon as primarily suited for attack on static population centers such as large cities, and thus our principal concern is with civil defense. There is little point at the moment in considering how it may be used against troops.

An important operational procedure in BW for an enemy would be to create an aerosol or cloud of agent over the target area. This fundamental concept has stimulated much basic research concerning the behavior of biologic particulates, the pathogenesis of respiratory infections, the medical management of such diseases, and defense against their occurrence.

The importance of particle size in such aerosols has been recognized. The natural anatomical and physiological defensive features of the upper respiratory tract, such as the turbinates of the nose and the cilia of the trachea and larger bronchi, are capable of impinging out the larger particles to which we are ordinarily exposed in our daily existence. Very small particles, however, in a size range of 1 to 4 microns are capable of passing these impinging barriers and entering the alveolar bed of the lungs. This area is highly susceptible to infection. The entrance and retention of infectious particles in the alveoli amounts almost to an intratissue inoculation.

In considering BW defense, it is well to know that there are a number of critical micrometeorologic parameters which must be met for an aerosol to exhibit optimum effect. Generally, bright sunlight is rapidly destructive to living micro-organisms suspended in air. There are optimal humidity requirements for various airborne agents. Neutral or inversion meteorologic conditions are necessary in order for a cloud to travel along the surface. It will rise during lapsed conditions. There are, of course, certain times during the 24-hour daily cycle when most of these conditions will be met. This is important in gas warfare also. Moreover, the importance of these meteorologic conditions has long been recognized in connection with certain natural phenomena such as the occurrence and persistence of smog over an area.

Certain other properties of small particles, in addition to those already mentioned in connection with penetration of the respiratory tract, are noteworthy in defense considerations. The smaller the particle, the farther it will travel downwind before settling. An aerosol of such small particles diffuses through structures in much the same manner as a gas, a property of considerable importance in connection with certain defensive considerations.

A number of unique medical problems might be created when man is exposed to an infectious agent through the respiratory route rather than through the natural portal of entry. Some

agents have been shown to be much more toxic or infectious to experimental animals exposed to aerosols of optimum particle size than by the natural portal. Botulinal toxin, for example, is several thousandfold more toxic by the respiratory route than when given by mouth. In some instances, a different clinical disease picture may result from this route of exposure, making diagnosis difficult. In tularemia produced by aerosol exposure, one would not expect to find the classical ulcer of "rabbit fever" on a finger.

There are a number of agents that an enemy might select from the several classes of microorganisms (bacteria, viruses, rickettsiae, fungi, or toxic products of certain organisms). There are, however, certain general characteristics that should be met in making a selection.

An enemy would obviously choose an agent that is believed to be highly infectious. Agents that are known to cause frequent infections among laboratory workers, such as those causing Q fever, tularemia, brucellosis, glanders, coccidioidomycosis, belong in this category.

An agent would likely be selected which would possess sufficient viability and virulence stability to meet realistic minimal logistic requirements. It is, obviously, a proper goal of research to improve on this property. In this connection an agent should be capable of being disseminated without excessive destruction. Moreover, it should not be so fastidious in its growth requirements as to make production on a militarily significant scale improbable.

An aggressor would seek minimal, naturally acquired or artifically induced, immunity in a target population. A solid immunity is the one effective circumstance whereby attack by a specific agent can be neutralized. It must be remembered, however, that there are many agents for which there is no solid immunity and a partial, or low-grade, immunity may be broken by an appropriate dose of agent.

There is a broad spectrum of agents from which selection for a specified military purpose might be made. An enemy might choose an acutely debilitating agent, a chronic disease producer, or one causing a high death rate.

It is possible that certain mutational forms may be produced such as drug-resistant strains. Mutants may be developed with changes in biochemical properties that are of importance in identification. All these considerations are of critical importance in considering defense and medical management.

One point needs serious emphasis. The likelihood of creating an entirely new agent of unique virulence, or new disease-producing capability, is extremely remote. Even the remarkable genetic progress made in producing bacterial transformation in recent years does not warrant deviation from this opinion at the present time.

Certain general considerations in connection with BW agents merit some discussion.

Biological agents are, of course, highly host-specific. They do not destroy physical structures as is true of high explosives. This may be of overriding importance in considering military objectives.

One must be unremitting in emphasizing that there is no secrecy concerning the agents which might be included in an overall BW arsenal. Only certain agents will meet the general and specific BW requirements. Both we and any potential enemy know them. This is not like inventing or rather synthesizing a new chemical poison. One frequently hears it said, "If we only knew what agents our potential enemies were working on, we would know what to defend ourselves against." This platitudinous statement is parroted ad nauseam. This is the kind of statement that is made by an ostrich before burying his head in the sand. A more appropriate conjecture would be to ask ourselves, "What are we doing about it? Are we doing enough?"

The question of epidemic disease also merits some discussion. Actually, only a limited effort has been devoted to this problem in the research and development program. Some of the bitterest critics of BW have assumed that the only potential would be in the establishment of epidemics. They then point out that with mankind's present lack of knowledge of the factors concerned in the rise and fall of epidemics, it is unlikely that a planned episode could be initiated. They argue further, and somewhat contradictorily, that our knowledge and resources in preventive medicine would make it possible to control such an outbreak of disease. We agree with this in general, and this is why this

approach to BW defense has not been given major attention in the program. One can charitably hope that such critics never have to breathe air laden with an infectious agent!

Our main concern is what an enemy may accomplish in the initial attack on a target. This, of course, does not eliminate from consideration for this purpose agents that are associated naturally with epidemic disease. A hypothetical example will illustrate this point. Let us assume that it would be possible for an enemy to create an aerosol of the causative agent of epidemic typhus (*Rickettsia prowazekii*) over City A and that a large number of cases of typhus fever resulted therefrom. No epidemic was initiated nor was one expected because the population in City A was not lousy. Lousiness is a prerequisite for epidemic typhus. In this case, then, the military objective was accomplished with an epidemic agent solely through the results accomplished by the initial attack. This was done with full knowledge that there would be no epidemic. On the other hand, a similar attack might have been made on City B whose population was known to be lousy. One might expect some spread of the disease in this case, resulting in increased effectiveness of the attack.

The great inherent potency of BW agents is due to their capacity to multiply when successfully implanted in a susceptible host.

Biological agents are, of course, suitable for delivery through enemy sabotage, which imposes many problems in defense. One can let one's imagination run wild in this regard. One might mention a few obvious, but nevertheless important, areas. The air-conditioning and ventilating systems of large buildings are obvious targets. America is rapidly becoming a nation that uses processed, precooked, and yes, even predigested foods. This is an enormous industry that is subject to sabotage. One must include the preparation of soft drinks and the processing of milk and milk products. Huge industries are involved also in the production of biologic products, drugs, and cosmetics which are liable to this type of attack. These few major areas have been mentioned since sabotage in them would be far reaching in its consequences. Furthermore, all are subject to prophylactic defensive action.

Our major defensive problems, of course, are concerned with the possibility of overt military delivery of biological agents from appropriate disseminating devices. It should be no more difficult to deliver such devices than other weapons. The same delivery vehicles—whether they be airplanes, submarines, or guided missiles—should be usable. If it is possible for an enemy to put an atomic bomb on a city, it should be equally possible to put a biological agent cloud over that city. This points up an enormously important civil defense problem which will be considered in more detail later.

Antifood BW

Another aspect of biological warfare is the possible use of biological agents for the reduction or destruction of agricultural crops and domestic animals, in other words, antifood biological warfare.

The importance of food, particularly during war, needs no emphasis. Actually food production is of major concern to most countries even during peacetime. We are one of the few countries in the unusual position of finding overproduction a major problem.

In all wars, moreover, military efforts have been devoted to the destruction of the enemy's food supply. The grain-laden freighter was as much a prize for a submarine as a ship loaded with tanks.

Biological warfare may find its greatest effectiveness when used for anticrop and antianimal purposes. Contrary to the case in antipersonnel BW, the epiphytotic and epizootic potential of anticrop or antianimal agents would be exploited by an enemy. Antifood biological warfare could play a decisive role in any war that was not decided with pushbutton speed. This country is in a favorable defensive position in anticrop warfare. Our cropping is very diversified and biological agents are, of course, specific for particular crops. Those countries that are generally dependent, for agronomic, climatic, or traditional reasons, on a single crop are the most vulnerable.

It is hoped that this general consideration of biological warfare will serve as a useful framework around which one can build one's defensive thinking and planning. Let us now con-

sider some of the general features of this problem.

Defensive Bank Account

It may seem trite, but nevertheless it is worth while to emphasize, that there is a vast amount of medical knowledge in existence which can be useful. In this sense BW is not completely new. We have had long medical and epidemiological experience with infectious diseases. We have a vast public health effort in being at the Federal, State, and local levels. Our sanitary engineering practices and methods for disease control are at a high level of efficiency. All of these are positive values in our defensive bank account which can be drawn upon in an emergency and would be of great value.

One must not be complacent, however, and be lulled into thinking that BW would be rendered ineffective by these aids. This is not so. These techniques have been developed over the years for dealing with naturally occurring infectious disease. The military exploitation of massive amounts of highly infectious agents through unusual portals of entry creates new problems for which these procedures were not designed and against which no experience has been developed. One might illustrate this point. Adequate means have been developed, for example, for delivering potable water to all inhabitants in a community. We now take this for granted. On the other hand, there is no known public health procedure that will deliver sterile air to all inhabitants of a city. Defense against a massive biological aerosol is a new and critically serious problem.

It is obvious, of course, that medical defensive planning for a community should not be limited to preparation for BW. BW will not cause extensive burns, broken bones, or radiation sickness. All defensive planning should be thoroughly integrated and should be designed to give the maximum practical relief for whatever disaster might befall. For the moment, however, we will consider BW defense only.

One of the most critical problems is detection or early warning. Biological clouds have no characteristics detectable by the senses. They are invisible, odorless, and tasteless, in contrast to certain gas clouds. Even if they possessed an odor, the odor-detecting sniff might result in a sufficient dose to produce an infection.

As is always true, an initial surprise attack will, of course, be the most serious. Later attacks may be suspected by their general characteristics such as possible noise of a disseminating device, recognition of a dud device, and, finally, the realization that something has been delivered that is not a conventional weapon.

The importance of such immediate detection and warning is that it may permit certain defensive actions of a physical nature. The gas mask, for example, affords excellent protection to the respiratory tract if it can be put on in time. Early warning may also permit timely entrance into collective shelters should they exist. It is possible to design quite efficient structures for this purpose.

Some progress is being made in the development of instrumentation for rapidly detecting unusual concentrations of particulate matter in the air.

A closely related problem is rapid specific identification of the particular agent. The ordinary biological methods, employed in the diagnostic laboratory, are far too slow. Identification of viruses is especially tedious. This problem is important in that if the agent can be identified in time, it may permit certain medical prophylactic procedures before the onset of illness. Progress is being made in this field, but much remains to be done. One might suggest at this time that any laboratory conducting research to improve and speed up identification of disease organisms will be making a significant contribution to the defense effort.

Defense Needs

Another defensive activity is decontamination or cleanup after an attack. Much technical knowledge has been developed in this field and is available to defense authorities. One might point out that most of the effort has been devoted to developing procedures for specific and isolated use. One could not hope to decontaminate an entire city. Indeed, this would not be necessary. Sunlight and time are remarkable decontaminants. One may have ur-

gent need, however, for decontaminating specific equipment, structures, or isolated areas.

The most important of all defensive procedures is prophylaxis by active biological immunization. A number of effective immunizing materials are already available for some infectious diseases. On the other hand, there are a number of potential BW agents against which there is no method of immunization. There are several cases where the value of the immunizing material continues to be questionable, at least or where improvement must be sought through research.

One must encourage all research possible that is devoted to the development of new or improvement of old methods of active immunization. All ancillary research dealing with host-parasite relationships will have positive defense value. Moreover, all such research has great peacetime value. It will not be totally consumed in an engine of war.

The administrative problems in connection with the immunization of large populations against a number of agents are enormous. This, too, is an area where research should be fruitful because simplified techniques for rapid, mass immunization are essential. Considerable effort is being devoted to the development of combined or multiple vaccines, an effort that is being rewarded with some success.

There is also the very large field of passive biologic and antibiotic prophylaxis, that is, the use of antimicrobic agents after exposure to the agent but before the onset of illness. This problem merits some detailed discussion.

The use of immune serums, even if effective, would be extremely limited in BW. The production and distribution of the enormous quantities required would be very difficult if not totally unrealistic. On the other hand, the desirability of having some stocks in hand for limited and specialized use should be kept in mind.

More detailed discussion is warranted in connection with the possible prophylactic use of antibiotics and chemotherapeutic drugs. The importance of this has been overplayed in the past. It is essential, therefore, to point out many of the shortcomings of this form of prophylaxis as a guide to future effort.

On several occasions, articles have appeared expounding the thesis that our enormous antibiotic industry has made biological warfare obsolete. This is, of course, ridiculous for a variety of reasons. To permit such reasoning to guide our preparation for defense would be suicidal.

There are many potential BW agents for which there is no known effective antibiotic or drug. Among these may be mentioned *Coccidioides immitis*, *Histoplasma capsulatum*, and, more importantly from a BW standpoint, most of the filtrable viruses.

While we have some antibiotics that exhibit a considerable spectrum of activity, there are others whose greatest value is in use against a specific agent. For prophylactic BW defense after an attack, it would mean, therefore, having the right antibiotic in the right amount at the right place at the right time—a logistic requirement that is almost impossible to meet. Even these considerations may be academic, moreover, when it is realized that the use of drug-resistant strains of agents is not an unlikely possibility.

In some cases it has been shown that giving an antibiotic immediately after exposure merely prolongs the incubation period without preventing infection. Our British colleagues have recently reported that monkeys exposed to lethal respiratory doses of anthrax spores could be treated for several weeks with an antibiotic and would show no signs of infection during that time. When the drug was withdrawn the animals promptly developed fatal anthrax.

One might conclude this discussion of strictly medical prophylaxis by emphasizing that the greatest hope for defense against BW would be the development of effective methods for producing active immunity. Passive prophylaxis with antibiotics and drugs may have limited value. This procedure must not, however, be regarded as a panacea that will render BW obsolete.

There are some additional activities that should be mentioned in connection with BW defense.

Maintaining an adequate epidemiological intelligence service and warning network is of great importance. An unusual occurrence of disease in a particular location may be the first

warning of a BW attack. The prompt recognition and reporting of such episodes is essential.

It is important to have available the services of an organized network of laboratories having the qualifications and equipment necessary for the recognition and identification of unusual agents. Such services are needed particularly in the virus field. The personnel in such laboratories should be trained and indoctrinated in those features of BW that may have a special bearing on their responsibilities. This should include training in the use of new detection devices and new procedures for more rapid identification of agents.

There must, of course, be adequate planning for optimum emergency hospital and medical service. Each community must plan the details in this connection.

Our defensive considerations may be concluded with a few words concerning prevention of sabotage. A careful vulnerability study should be made of all sensitive industries and facilities to determine the most likely spots of attack. There should be proper policing and guarding of such spots. Loyal employees should be indoctrinated to the point of being able to augment such guarding. Adequate chlorination of water supplies should be assured. Air-conditioning and ventilating systems of sensitive buildings should be appropriately protected. And, finally, one must not neglect the simple but very effective techniques of heating or boiling food products.

INTERNATIONAL MAIL POUCH

Surinam Sojourn

As a guest of a medical service expedition in Surinam, I was able to study some of the pathologies of Bush Negroes and Amerindians. Four doctors are assigned to serve villages scattered through 43,000 square miles of jungle. At present, only two are well and working. They travel primarily by canoe or small motor craft along rivers and creeks, notwithstanding falls, rapids, logs, alligators, and pythons. There are no roads through the jungles. To follow footpaths and camp overnight is not advisable. The waterways are less strenuous and safer.

—HILDRUS A. POINDEXTER, M.D., *chief public health officer, United States Operations Mission, Surinam.*

Pass the Water

I think we watered an acorn this month. After a year of preliminaries, the provincial government authorized the city of Taipei to hire engineers for the establishment of a sewerage unit. Two weeks ago the mayor decided to activate the unit to design a waterborne sewerage system, initially for the residential half of the city, and to make an official request for the assistance of a WHO design engineer. The start of work was set for the first of the month. Rule-of-thumb cost estimates indicate the project will approximate NT$500,000,000—sufficient to dwarf any other sanitation project now contemplated.

—JAMES P. WARD, M.D., M.P.H., *chief, Public Health Office, United States Operations Mission, China (Taiwan).*

Tribal Vaccination

"May Allah bless you! You young men have risked your lives by crossing these mountain passes to save our lives." A Bakhtiari tribal chief spoke thus to the physician in charge of the Isfahan tribal vaccination program.

The vaccination team first found out what routes the tribesmen in Iran would use on their way to summer pastures and the time they would begin to move. A six-man unit then waited at the mountain pass most of the vast Bakhtiari tribe were to cross. Another unit set up a field clinic at a bridge along the route used by others.

About 200,000 nomads, never before touched by a public health program, were vaccinated against smallpox in Iran within a few weeks.

—ALBERT P. KNIGHT, M.D., *chief, Health Division, United States Operations Mission, Iran.*

A broad survey of information on the epidemiology of toxoplasmosis with an evaluation of data on the transmission of this infection.

The Interrelation of Toxoplasmosis in Swine, Cattle, Dogs, and Man

LEON JACOBS, Ph.D.

THE ORGANISM *Toxoplasma gondii* is an obligate intracellular parasite. Until now, no form has been found which is capable of living for extended periods outside the cells of its numerous hosts. It is capable of invading and multiplying in a wide variety of cell types, such as neurons, microglia, endothelium, reticulum, parenchyma cells of the liver, epithelial cells of the lung and glands, and cardiac and skeletal muscle.

The parasite exists in two forms. The proliferative form, seen during the acute stage of the infection, undergoes rapid intracellular multiplication, and the numerous loosely grouped toxoplasmas thus produced are liberated by rupture and invade new cells. This form of the parasite is motile, showing twisting movements of its attenuated end and gliding movements unaccompanied by any changes in shape or surface visible by ordinary light microscopy. It measures about 3 by 6 microns, has a centrally located nucleus, and glycogen granules of small size. The pseudocyst form probably appears late in the subacute stage of the infection and is the only form which persists in chronic infections. Pseudocysts are generally larger in size than the cells parasitized by proliferating forms. The parasites within them, which are closely packed and more lanceolate, have a subterminal nucleus and larger glycogen granules (*1*). The latter can be considered characteristic of a resting organism.

The wall of the pseudocyst is considered by some workers as the remains of the host cell wall to which are added some products of the parasite. Others regard it as primarily of parasitic origin. Whatever its origin, the wall of the pseudocyst is argyrophilic and elastic, and at least somewhat resistant to mechanical damage. Also, the psudocyst appears to be more resistant to environmental changes than are proliferative forms (*2*).

According to a number of workers, proliferative forms of *Toxoplasma* die rapidly outside the host and in the carcass of dead animals. These forms are destroyed on drying, on changes in osmotic pressure, and on exposure to low heat. Pseudocysts are also unable to withstand drying and are killed by low heat. However, they may survive in dead tissues for up to 2 weeks or longer at refrigerator temperatures, possibly with less attrition than proliferative forms (*3*). The point of greatest difference is in survival during digestion. It is revealed indirectly by feeding experiments.

Tissues of mice dying of acute toxoplasmosis fed to other mice produce relatively few infections (*4*). However, when tissues from chroni-

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cally infected mice (*5*) or rats (*2*) are fed to mice, more infections result. Acutely infected animals have mainly or only proliferative forms of the parasite, while in chronic infections only pseudocysts are found. It thus appears that pseudocysts are more resistant to digestion.

Epidemiological Data

Toxoplasma gondii is not only indiscriminate as to the cells it parasitizes, but also as to the hosts it infects. It has been isolated in a wide variety of mammals, including primates, artiodactyla, carnivores, rodents, marsupials; in domestic birds such as chickens, pigeons, and ducks; and in wild pigeons and crows. Additional morphological reports, especially on birds, cover some 45 species, but these have not been confirmed. There are also morphological reports of the parasite in reptiles, which have not been confirmed by isolation. In present-day work, it is expected that, in addition to finding the organism, identification will be established by serologic and immunological methods. Other birds such as the canary and grackles, however, and turtles, terrapins, and chameleons have also been given infections in the laboratory.

Toxoplasmosis occurs among animals in both endemic and epidemic form. Surveys in various localities have yielded a number of isolations of the parasite from pigeons, rabbits, rats, dogs, cats, mice, ducks, and chickens. These isolations have been made from healthy animals apparently carrying latent infections. In addition, epidemics of acute toxoplasmosis have occurred on pigeon, chicken, rabbit, and chinchilla farms. Toxoplasmosis has also occurred among wild hares in Denmark, in herds of cattle in Ohio, and in swine in Ohio and Norway (*2*).

Human infections, as far as we know, occur sporadically. Fortunately, we have not seen epidemics of the disease due to this parasite, and even in individual family groups serologic tests reveal that some members have experienced infections while others have not. Human infection has been found all over the world. Apparently there is continued exposure to the parasite throughout life, because there is an increasing proportion of positive serologic reactions with increasing age. Serologic surveys have revealed no differences in prevalence between the sexes, except for one report regarding a Swedish island in the Baltic Sea (personal communication from Dr. Sven Gard of the Sachs' Hospital for Children and the Institute for Virus Research, Stockholm). The sex difference was not found on the mainland of Sweden.

There are differences in geographic prevalence of toxoplasmosis. There is relatively less infection in California than in the east. Comparisons of various cities of the United States and of such widely separated populations as those in Tahiti, Alaska, Iceland, and Haiti show considerable differences (*6*). For instance, Portland, Oreg., has an overall prevalence of about 18 percent, St. Louis 25 percent, New Orleans 31 percent, and Pittsburgh 36 percent. The island of Haiti has a prevalence figure resembling that of Pittsburgh, while Tahiti shows almost 70 percent infected. Icelanders have a low prevalence, and Alaskans are almost entirely free of antibodies. The prevalence is higher in southern than in northern Sweden.

Whether these differences are related to climate is difficult to determine. Accumulated data suggest that toxoplasmosis is more prevalent in warm, moist areas than in cold or hot, dry areas. The coastal areas of Mexico show higher prevalence rates than the region around Mexico City; and the rate among Navajo Indians in Arizona is surprisingly low. There are clues difficult to decipher at present (*2*).

Because toxoplasmosis has been found in practically all domestic animals, a number of postulates have naturally been advanced on the importance of these animals as reservoirs of the infection for man. To cite only a few, Otten, Westphal, and Kajahn reported finding correlations between canine and human toxoplasmosis (*7*). Cole and associates stated that toxoplasmas were found in the blood of an asymptomatic woman whose dog had earlier suffered an undiagnosed disease and at the time of the study showed *Toxoplasma* antibodies (*8*). In a personal communication, Sabin stated that R. H., the unfortunate boy from whose brain was isolated the widely used strain of *Toxo-*

plasma designated by his initials, had had a cat in his household that died of an undiagnosed infection some time before the boy became ill. After the finding of *Toxoplasma* in swine (*9*) and in cattle (*10*), the postulate was advanced that humans acquire the infection from pork and beef.

An outstanding example of infection among humans and animals in relatively close contact was reported by Gibson and Eyles at the meetings of the American Society of Tropical Medicine and Hygiene in November 1956. The investigation started with a fatal case of congenital toxoplasmosis in a woman in Memphis. Tests on her two older children showed high levels of antibodies, but those on her husband proved negative. The family house was close to a garbage dump frequented by numerous stray animals. Examinations of animals caught in the area resulted in isolation of *Toxoplasma* from cats, dogs, mice, pigeons, ducks, and chickens. Thus the infection appears widespread; it seems that there is a sea of *Toxoplasma* infection around us. In order to evaluate the importance of various animals in the spread of the infection to man, it is necessary to relate the characteristics of the infection in many hosts and also to observe the strain differences in the parasite.

Characteristics of the Infection

The acute stage of the infection is initiated after an incubation period which varies in length depending on the size of the inoculum. During the incubation period, there is local proliferation of the parasite at the site of inoculation. This is followed by the generalized spread of the organism through the blood stream and the invasion of susceptible tissue cells all over the body. In these tissues, parasites multiply, with the production of focal areas of necrosis. In animals succumbing to the infection, parasitemia mounts to high levels. Also, in animals with acute toxoplasmosis, parasites are found in the urine and feces of mice and dogs; in the milk of mice, sows, cows, and bitches; in a serous exudate from the conjunctiva of a pigeon; in saliva of mice and rabbits. They have also been demonstrated in one instance in saliva of man (*2*).

The parasites which are released to the outside from such acutely ill animals are proliferative forms. This form of the parasite is very delicate; it does not survive long outside its hosts. This is attested to by the fact that there is little spread of toxoplasmosis among animals even closely confined in the laboratory. Clean mice in the same jar with infected mice do not become infected. There is only one report of such transmission, in which uninfected puppies caged with a littermate dying of toxoplasmosis eventually became infected (*11*). We have been unable to repeat this observation under similar circumstances. Despite the finding of parasites in the lungs and in saliva of rabbits, an attempt in our laboratory to produce infections in these animals by spraying large numbers of proliferative parasites into a confined space holding clean rabbits did not result in transmission. It appears that only under exceptional circumstances of very intimate contact can transmission be effected from sick animals.

The subacute stage of the infection is characterized by the appearance of serum antibodies and by a clearing of the parasitemia. Following this, there is a gradual clearing of the tissues. This has been measured in rats (*12*), in dogs (*13*), in chickens (*2*), and in pigeons (*14*). We also have unpublished data on guinea pigs and cats, and Eyles and his co-workers have additional information on chickens. In general, the liver, spleen, and lung clear of parasites relatively rapidly, the heart somewhat later, and the brain last of all.

The persistence of parasites in pseudocysts is characteristic of the chronic form of the infection. In the brain of mice, rats, and pigeons, parasites have been found for as long as 3 years after infection, and in the brain of dogs, 9 and 10 months after infection. Occasionally other organs are also found positive. In the liver of a dog, for example, we demonstrated parasites 2 years after inoculation. Unfortunately, not enough studies have been made of skeletal muscle to say how long this tissue usually harbors pseudocysts. There is probably considerable variation from host to host in this respect. For example, we found that the skeletal muscle of chickens clears very rapidly following experimental infection. On the other hand, in tests of chronically infected rats currently underway

in our laboratory, some have shown muscle still infective 6 months after inoculation. We have also found muscle positive in a case of human lymphadenopathic toxoplasmosis at least 3 months after onset of the infection, and Kass and associates found the parasites in the muscle of a fatal human case (*15*). Occasional histopathological findings of parasites in human and animal muscle without any inflammatory reaction in surrounding tissues indicate that pseudocysts may persist in the flesh of apparently cured cases. Because of the variation from host to host, each species of host must be studied individually, and some quantitative data must be gathered as to the relative frequency of this occurrence. It is also necessary to study a wide variety of strains of the parasite in these hosts.

Variations in Parasite Strains

Strains of *Toxoplasma* isolated from various species of animals and birds are biologically and immunologically similar, and on this basis only one species of parasite, *T. gondii*, is recognized. However, some variation in strains has been noted. The main criteria for describing strain differences are the virulence of the parasites for laboratory hosts and the characteristics of the disease produced in them.

A comparison of infections produced by a number of virulent strains and by one of relatively low virulence shows that strains highly virulent for mice usually produce the most severe disease in the other laboratory hosts. There is, in general, a lower parasitemia, less tissue invasion, and shorter persistence of parasites in infections with a strain of low virulence. A sudden change in virulence has been reported by Lainson who found that avirulent strains isolated from rabbits were greatly enhanced in virulence by passage through multimammate rats (*16*). Strains isolated from sick animals in nature are frequently highly virulent for experimental hosts. Strains isolated from animals without disease are more likely to produce latent infections in the laboratory. This has been our experience with strains isolated from a dog and from pigeons. Similar reports have been made concerning strains from rabbits, guinea pigs, dogs, cats, and other natural hosts. Since surveys have revealed considerable natural infection in man and animals, and relatively little disease, it seems reasonable to conclude that the parasite as it exists in nature is well adapted to its hosts and that it produces little disease unless it undergoes some spontaneous change or encounters a host which is peculiarly susceptible.

The susceptibility of the host is important. Erichsen and Harboe described an epidemic of toxoplasmosis in a flock of chickens in Norway (*17*). The parasite was isolated and maintained in the laboratory in mice but failed to produce fatal experimental infections in chickens, even when birds were used of the same breed as those on the affected farm. In our laboratory, we have been unable to produce disease in chickens even with large inoculums.

Toxoplasmosis in Dogs

Mello first described spontaneous toxoplasmosis in a dog, with diarrhea, emaciation, anemia, dyspnea, and abdominal tenderness (*18*). Since this report, over 50 cases of the infection in dogs have been reported from all parts of the world (*16*, *19*). Some of these cases were fatal, and others merely were coincidental findings of parasites in histological sections of tissues of dogs dead of other diseases.

There is also serologic evidence that dogs are frequently found infected in nature. Miller and Feldman found dye test antibodies (titers of 1:16 or more) for *Toxoplasma* in 59 percent of 51 dogs at Syracuse, N. Y. (*20*). Siim found 18.5 percent of 54 dogs in Copenhagen had relatively high dye test titers, 1:250 or more (*21*). Otten and associates in Hamburg, Germany, found 35.7 percent of 84 dogs positive by the same test (*7*). Morris and associates examined, by the complement fixation test, 180 dogs from the Middle Atlantic States, and found 25 percent infected (*22*). Lainson, in England, found 42.5 percent of 113 serums from London dogs positive by the complement fixation test (*23*).

Thus, the dog merits attention as a possible reservoir of the infection for man. Miller and Feldman (*20*) and Jacobs and associates (*13*) have pointed out that the widespread occurrence of *Toxoplasma* antibodies among humans and dogs makes it difficult to decide in any particu-

lar case that an infection in a canine pet is related directly to human infection. Nevertheless, a number of instances can be cited from the literature in which "sickness" in a dog occurred in a household where there was a human case of toxoplasmosis. Westphal and Finke report that a woman with a dye test titer of 1 : 100 had an abortion of an infant with hydrocephalus; the woman's husband and pet dog also had positive tests (*24*). In another case of congenital toxoplasmosis proved by isolation of the parasite, three dogs in the household of the mother had suffered a disease considered clinically, by hindsight, suggestive of toxoplasmosis; the dogs were not tested for antibodies.

In still another case, a sick dog was found in the home of a woman who had borne a hydrocephalic infant. They also reported that a woman with nervous symptoms and a dye test titer of 1 : 200 had 6 months previously lost a dog which was diagnosed as having distemper. Prior and associates reported 3 cases diagnosed as toxoplasmosis, 2 in women and 1 in a child (*25*). The women both had dogs which were found to have toxoplasmosis. A human case of myocardial toxoplasmosis in England (*26*) proved by isolation of the parasite from the heart (*27*) had been associated with a dog sick with vomiting and diarrhea. Miller and Feldman also cited a sick dog in a household where a case of congenital toxoplasmosis occurred (*20*).

In all of these cases, no evidence was presented that the disease in the animals was definitely toxoplasmosis, except for the report of Prior and associates. Their study presents its own problems in that the dye test titers found in their two adult cases were much lower than those reported by others in proved cases of systemic toxoplasmosis in adults, either mild or acute. Also, the dye test titer in the dog of one of these cases was again surprisingly low relative to the duration of the illness. These reports stimulate further investigation.

Because of the widespread and frequent occurrence of *Toxoplasma* antibodies in both humans and dogs, any correlation between the infection in these two hosts depends on extensive survey techniques. Otten and associates tested 38 people whose dogs had *Toxoplasma* antibodies; they found 23 had dye test titers of 1 : 25 or higher (*28*). Unfortunately, they had no control group of people in the same age groups and circumstances, and the survey is small. Otten and associates also reported that 5 of 6 veterinarians, 3 of 5 veterinary assistants, and 3 of 3 kennel keepers all had *Toxoplasma* antibodies demonstrable by the dye test. Cole and associates in this country also reported a correlation between *Toxoplasma* antibodies in pets and their masters (*8*). It appears from these studies that there may be a relation between human and canine infections. However, there have been cases of human toxoplasmosis which have not had even remote contact with dogs. This suggests that if the dog is a reservoir of infection for humans, it is not the only such reservoir. Because of their association, dogs and man may acquire toxoplasmosis from the same source or sources.

Experimental canine toxoplasmosis has been studied by a number of investigators with similar results. Nicolle and Conor (*29*), Boez (*30*), and Westphal and Finke (*24*) could not produce disease in mature dogs by the inoculation of virulent parasites by various routes. Laveran and Marullaz produced disease by the intravenous inoculation of parasites (*31*). Chamberlain and associates were able to produce acute toxoplasmosis in 5 bitches 1½ to 2 years of age, by the intravenous inoculation of large numbers of parasites supplemented by additional injections subcutaneously or intraperitoneally, or by oral administration of as many or even larger numbers of organisms (*32*).

Even with these efforts, only two deaths occurred among these animals and one of them remained entirely asymptomatic. In 4 of 8 puppies 45 days of age or less, Jacobs and associates produced acute toxoplasmosis by intravenous inoculation, in 3 instances, of 100,000 parasites of the RH strain, and the fourth puppy succumbed to an intravenous inoculation of 10,000 parasites plus a concomitant infection with 200 hookworm larvae (*13*). Other puppies, including a littermate of the fourth puppy, 5 weeks to 3½ months old, survived intravenous inoculation with 10,000 parasites, or in the case of one 65-day-old dog, 2 million parasites.

Thus, it appears that canine toxoplasmosis is difficult to reproduce in the laboratory, similar

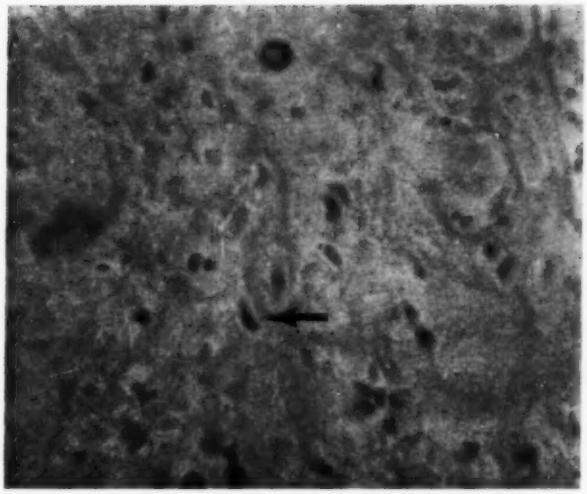

Figure 1. Proliferative forms of Toxoplasma gondii in necrotic liver tissue from a mouse. Arrow indicates one of the organisms.

to the phenomenon mentioned above in regard to chickens. Possibly it is explainable on the basis of sudden changes in virulence described by Lainson (*16*) or by the existence of concomitant viral infections, as noted by Seibold (*33*) and others.

Although puppies with acute toxoplasmosis had parasites in their urine and feces, Chamberlain's bitches had infective milk, and possibly the saliva of dogs can contain toxoplasmas when the lungs are heavily parasitized, these findings are generally limited to animals in the acute stage of the infection, and to those with severe disease symptoms. In our experimental studies on dogs surviving the infection, we could not demonstrate parasites in the feces or urine, even though isolations could be made for at least 2 weeks from the lung, liver, and spleen.

The course of the infection in dogs begins with a period of parasitemia lasting up to 2 weeks, characterized by a generalized spread of the parasite. At about 2 weeks, antibodies appear, the parasitemia ceases, and there appears to be a diminution of parasites in the tissues, as revealed by longer survival time of mice inoculated with them. However, some parasites remain in pseudocysts and can be occasionally isolated from the brain or other organs long after infection. Older dogs were not found to have a parasitemia.

These results are consistent with the usually asymptomatic toxoplasmosis found in dogs in nature. It is hardly likely that natural infections are initiated with tremendous numbers of parasites. Hence, when evidence of past exposure to *Toxoplasma* is found in an apparently healthy animal, there is little reason to suspect that the dog experienced an acute symptomatic infection. Since only acutely ill dogs exude toxoplasmas in their excretions and secretions, and since the proliferative toxoplasmas survive only briefly in the external environment, it seems unlikely that acute disease in dogs is a usual source of human toxoplasmosis. Furthermore, our attempts at producing infections by feeding mice urine and feces of dogs with asymptomatic infections resulted in failure. We therefore lack good evidence of any mechanism by which canine toxoplasmosis can be transmitted to man. Indeed, Feldman and Miller have found that Navajo Indians in Arizona have a very low prevalence of *Toxoplasma* antibodies, while their dogs show a relatively high prevalence (*34*).

One feature of canine toxoplasmosis deserving special mention is the intestinal ulceration frequently reported in spontaneous cases of the infection. This has also been reported in other carnivores, such as cats, foxes, and ferrets. This suggests, first, the need for more studies to determine whether a resistant form of *Toxoplasma* can be shed in the feces from such intestinal lesions, and secondly, whether these animals acquire toxoplasmosis by the ingestion

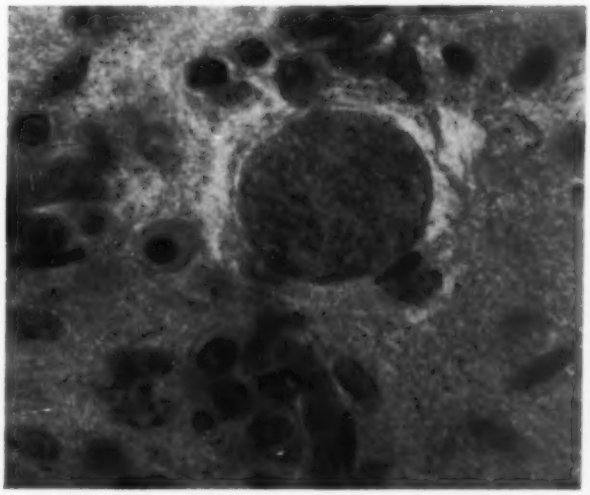

Figure 2. Pseudocyst of Toxoplasma gondii in the brain of a mouse.

of infected flesh. The latter hypothesis has support in the observation of Lainson that 2 of 4 dogs with *Taenia* infections had *Toxoplasma* antibodies, while only 1 of 10 dogs without *Taenia* was serologically positive (*23*). It also has support from already mentioned data on the successful infection of mice by feeding them brains of chronically infected mice and rats, and from some recent studies of the same type using various muscles of rats with latent infections (*35*). Furthermore, we have seen, in at least one dog, a rise in dye test antibodies following the feeding of infected tissue. Therefore, the source of toxoplasmosis in carnivores could conceivably be small animals serving as their prey, or infected meat from larger animals. And, if carnivores can be so infected, what is the situation in regard to omnivores such as man? This brings us to an evaluation of present data on swine and cattle toxoplasmosis.

Toxoplasmosis in Swine and Cattle

Toxoplasmosis was first reported in swine by Farrell and associates in Ohio (*9*). Eleven animals were involved, all of which came from one herd where a recurring undiagnosed disease had existed for many years. Parasites resembling *Toxoplasma* were first observed in pathological sections of a gilt which had died of the disease. Thereafter, similar organisms were seen in 7 additional pigs, 2 of which had died, and the others of which had been destroyed. Suspensions of tissues from eight affected pigs were inoculated into mice. The organs used for these isolation studies were brain, heart, lung, pooled liver and spleen, mesenteric lymph node, and kidney. The pooled liver and spleen inoculum from one pig and the heart of a second pig produced toxoplasmosis in recipient mice. The organisms were identified biologically and immunologically as *Toxoplasma.*

One healthy pig from another farm was inoculated with mouse tissues containing this porcine strain of *Toxoplasma.* At one month, the dye test titer of this animal was 1:160, and toxoplasmas were isolated from its tissues by mouse inoculation. The parasite was also found pathogenic for 2 more healthy pigs, 2 dogs, and 87 mice. In a second report from Ohio, Sanger and Cole stated that they had isolated *Toxoplasma* from some pigs of a naturally infected sow (*36*). Also, the parasite was reported found in the milk of 2 naturally infected sows and 1 experimentally infected gilt, and from the placentas of 2 experimentally infected gilts.

Another outbreak of toxoplasmosis has recently been reported in swine in Norway by Momberg-Jorgensen (*37*). Eleven piglets were involved in this epidemic. In neither this nor the Ohio reports were the hog-feeding practices on the affected farms mentioned.

In addition to these reports, Weinman and Chandler have presented experimental and observational evidence representing an apparently impressive indictment of the pig as a source of human infection (*38*, *39*). In the first study they fed seven young pigs repeatedly with tissues from mice and rats infected with the RH strain of *Toxoplasma.* In two of these pigs, toxoplasmas were later isolated from the brain; in a third the blood was infective to mice on the seventh day after feeding. The other four pigs were all negative in mouse inoculation tests, but there were some increases in dye test titers. Unfortunately, it is not clear from their report whether or not muscle of these pigs was tested for the presence of parasites. However, in another experiment reported in the same paper, they studied an additional seven pigs, all of which they inoculated with millions of parasites (*38*).

One infection of a 15-pound pig ended fatally in 6 days following intracardiac inoculation. In this case, it was reported that toxoplasmas were isolated from ham as well as from brain, heart, lung, liver, and spleen. Three of the other pigs which received these parenteral inoculations were examined for the presence of parasites. In one, the brain was found positive; in another, the blood on the 6th day and the lung on the 42d day; the 3d was negative. Again, no mention was made of whether or not other tissues, such as striated muscle, were tested. Older animals were regarded as less susceptible to infection; the pig found negative after parenteral infection was 4 months old when first used.

In their second paper, Weinman and Chandler report on finding 42 percent positive for

Toxoplasma antibodies among 88 hog serums obtained at a slaughterhouse in New Haven, Conn. (*39*). Furthermore, most of the hogs with antibodies were from one farm, where 16 of 21 pigs examined (over 76 percent) had dye test antibody titers of 1:64 or higher. This farm did not cook the garbage it used as feed, and in addition the premises were overrun by rats.

Weinman and Chandler liken toxoplasmosis to trichinosis and consider it probable that there is transmission from swine to swine, rat to swine, and swine to man. They adduce as additional supportive evidence for this hypothesis certain serologic data on humans. Forty specimens of human trichinosis serums were tested for dye test antibodies; of these, 23 percent were positive at titers of 1:64 or higher, and 18 percent were positive at 1:256 or higher. Because these serums came from all over the United States, they could not assemble an adequate control group of nontrichinosis serums. However, they compare their data with those of Feldman (*6*) for Portland, Oreg., and New Orleans, and with those of Jacobs and associates (*40*) for non-pork-eating orthodox Jews. They conclude that their sample has a higher incidence of high dye test titers than these groups, and presume their sample was of older age and therefore should have had lower titers. There is no justification for such a presumption in regard to the Jewish serums, which were practically all from people in age groups from 45 to over 70 years.

Although this thesis is based on circumstantial evidence, some of which is subject to criticism, this evidence represents more positive information than has been obtained in tests of other postulated mechanisms of transmission, such as by arthropods, contaminative means, or droplet infection. There are, however, certain contrary data which require reconciliation with this hypothesis.

First, the prevalence of *Toxoplasma* antibodies, as already mentioned, varies from city to city within the United States. It is higher in the east than it is on the west coast, and higher in the south than the north. On the other hand, the prevalence of trichinosis in the northeastern States and in California is about the same (*41*), while it is lower in the southern than the northeastern regions. Secondly, the highest prevalences of *Toxoplasma* antibodies have been found in areas such as Tahiti or Guatemala, among populations that only rarely consume meat or do so only when it is well cooked. Third, in a survey of orthodox Jews in the older age groups in New York, 48 percent were positive for *Toxoplasma* antibodies (*40*).

The explanation offered by Weinman and Chandler for such discrepancies is that while pork may be one of the more important modes of transmission of human toxoplasmosis, several other sources may exist. Therefore, the failure to find correlations with pork is not definitive. There is merit in their argument. The high prevalence in Tahiti and Guatemala and in persons who do not eat pork can mean that another method of transmission is involved.

We have, therefore, attempted to determine whether meat other than pork accounts for the high prevalence in persons who do not eat pork. We tested the serums of a group of vegetarians belonging to the Seventh Day Adventist sect, and our findings are reported here for the first time.

Forty-six specimens were obtained, mostly from people over 40 years of age who had not eaten flesh for at least 20 years. The percentage of positive dye tests in this group was 21.6, somewhat lower than might be expected in the general population. However, we do not have a good control series for comparison because of the widely different geographic origins of the individuals involved.

Among the positives, high dye test titers were found. The titer distribution is as follows: 1:16, 1 serum; 1:32, 1 serum; 1:64, 3 serums; 1:256, 4 serums; 1:1,024, 1 serum. The highest titer was obtained in a woman 31 years of age who had never eaten meat in her life. The titers of 1:256 were obtained in people who had not eaten meat for 30 or more years. Thus, even though the percentage of positives in this vegetarian population is small, these high titers point to another means of acquiring *Toxoplasma* infection than by ingesting meat.

The gap in the experimental evidence presented by Weinman and Chandler is their failure to report or find parasitized muscle in their infected pigs. Since the distribution of parasites in tissues varies according to type of host,

we cannot presume that toxoplasmas persist in the skeletal muscle of pigs merely because they have been found in the brain or lung. Furthermore, the finding of infected muscle in an animal dying of acute toxoplasmosis on the sixth day following intracardial inoculation of large numbers of parasites is not adequate evidence for presuming that parasites become distributed throughout the muscle of pigs with asymptomatic infections. Finally, repeated feedings or inoculations of heavily infected material do not duplicate natural conditions. Experimental studies should be prosecuted with smaller inoculums.

In connection with toxoplasmosis in cattle, the report of Sanger and associates concerned four herds in Ohio (*10*). A 4-year-old cow from one herd, which reacted positive to the toxoplasmin skin test, was killed 14 days after she bore a calf. She had no visible illness, and no organisms were recovered by mouse inoculations from heart, brain, liver, spleen, ovary, lymph nodes, adrenals, or skeletal muscle. Microscopic bodies, considered *Toxoplasma*, were, however, reported seen in the uterine wall, spleen, and lung; and 1 of 8 mice inoculated with colostrum from the right front teat developed toxoplasmosis. None of eight mice inoculated with colostrum from the other teats became infected. The calf was killed following birth, and one mouse inoculated from it died of toxoplasmosis; it is not clear from the report which of the organs used, brain, heart, liver, spleen, mesenteric node, or kidney, was the source of the infection. Toxoplasmas were found only in the liver on microscopic examination. In the same herd, 3 cows between 3½ and 5 years of age developed nervous disturbances and died, but no infections could be found in them. Also, of 31 calves born in this herd, 3 were born dead, and 4 developed an obscure illness from which 2 died. No evidence of infection was found in them.

In a second herd, there was a history of continual sickening and death of newborn calves. The symptoms were dyspnea, coughing, sneezing, nasal discharge, and frothing at the mouth, trembling, shaking of the head, dehydration, and occasionally diarrhea with blood and mucus. Forty-five of 78 calves died between the ages of 1 day and 6 months. One 4-week-old calf was killed and its tissues tested by mouse inoculation. Brain, heart, liver, lung, spleen, kidney, pericardial fluid, and cerebrospinal fluid were inoculated separately into mice. Toxoplasmas were recovered in mice inoculated from the lung but not from the other organs. Histologically, toxoplasmas were reported in lesions of the brain, lung, and bronchial lymph node.

In the third herd, one bull developed anorexia, weakness, ataxia, prostration, chewing movements, and bicycling. It died 1 week after onset of illness. Microscopic examination revealed both free and intracellular organisms identified as *Toxoplasma* in the brain.

In the fourth herd, a 7-year-old cow died 2 weeks after parturition. The symptoms were anorexia, diarrhea, depression, fever, and mastitis. *Toxoplasma* was demonstrated microscopically in the lungs, myocardium, pericardium, kidney, gastric lymph node, and stomach; apparently no mouse inoculations were attempted. Some calves in this herd later died of an undiagnosed illness.

In an attempt to determine if *Toxoplasma* alone could be responsible for the symptoms seen in these herds, Sanger and his co-workers inoculated, by various routes, four healthy calves 4 to 90 days old with infective material from mice. Two control calves received a Seitz filtrate of the inoculum. The four test animals developed respiratory and nervous system disease similar to that previously observed. Two died and two recovered. Organisms identical with those seen in spontaneous cases were found microscopically in the lung, brain, liver, and spleen of 3 of the calves, and toxoplasmas were isolated from tissues of 2 of them.

The isolation of toxoplasmas only from the colostrum of a cow, even though the parasites were seen microscopically in other organs, is surprising. It is generally easier to isolate parasites than to detect them in sections. Perhaps this result is explainable on the basis that the inoculations and sections were done from widely separated pieces of the organs; or that strains of *Toxoplasma* in cattle are not well adapted for growth in mice.

This latter postulate could also serve to explain the other isolation failures when organisms could be demonstrated histologically.

However, it is hardly acceptable in the experimental studies where calves were inoculated with materials from infected mice. It is unclear from the paper whether all the isolations were made from the calves which died of experimental infection, or from those which survived.

Obviously, more work must be done on toxoplasmosis in swine and cattle. Experimental data are needed on the distribution of parasites in the muscles of pigs and cattle following inoculation with small numbers of parasites and in the absence of symptoms. Survey data are necessary on the presence of *Toxoplasma* pseudocysts in meat bought at market. Even if meat is involved, we certainly require considerable new information to explain the other means of transmission which must exist.

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Studies conducted in the Laboratory of Tropical Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Public Health Service, subsequent to the preparation of this discussion have recently led to the development of a technique for the survey of meat samples to detect *Toxoplasma*. The parasite has been isolated from diaphragm muscle of 11 of 50 pigs slaughtered at a Baltimore abattoir. A similar survey is being conducted on beef (*42*).

REFERENCES

(*1*) Frenkel, J. K., and Friedlander, S.: Toxoplasmosis. Pathology of neonatal disease. Pathogenesis, diagnosis and treatment. PHS Pub. No. 141. Washington, D. C., U. S. Government Printing Office, 1951, 105 pp., 38 plates.

(*2*) Jacobs, L.: Propagation, morphology, and biology of *Toxoplasma*. Ann. New York Acad. Sc. 64: 154–179 (1956).

(*3*) Jacobs, L., and Melton, M. L.: Studies on the resistance of pseudocysts of *Toxoplasma gondii* (abstract). J. Parasitol. 43 (suppl.): 38, October 1957.

(*4*) Jacobs, L.: The biology of *Toxoplasma*. Am. J. Trop. Med. & Hyg. 2: 365–389 (1953).

(*5*) Eichenwald, H.: Experimental toxoplasmosis. I. Transmission of the infection *in utero* and through the milk of lactating female mice. Am. J. Dis. Child. 76: 307–315 (1948).

(*6*) Feldman, H.: The chemical manifestations and laboratory diagnosis of toxoplasmosis. Am. J. Trop. Med. & Hyg. 2: 420–428 (1953).

(*7*) Otten, E., Westphal, A., and Kajahn, E.: Ueber das Vorkommen von Toxoplasmose beim Hunde: statistische Ehrebungen. Monatsh. f. prakt. Thierh. 2: 305–308 (1950).

(*8*) Cole, C. R., Prior, J. A., Docton, F. L., Chamberlain, D. M., and Saslaw, S.: Toxoplasmosis. III. Study of families exposed to their *Toxoplasma*-infected pet dogs. Arch. Int. Med. 92: 308–313, September 1953.

(*9*) Farrell, R. L., Docton, F. L., Chamberlain, D. M., and Cole, C. R.: Toxoplasmosis. I. *Toxoplasma* isolated from swine. Am J. Vet. Research 13: 181–185 (1952).

(*10*) Sanger, V. L., Chamberlain, D. M., Chamberlain, K. W., Cole, C. R., and Farrell, R. L.: Toxoplasmosis. V. Isolation of *Toxoplasma* from cattle. J. Am. Vet., M. A. 123: 87–91 (1953).

(*11*) Olafson, P., and Monlux, W. S.: *Toxoplasma* infection in animals. Cornell Vet. 32: 176–190 (1942).

(*12*) Ruchman, I., and Fowler, J. C.: Localization and persistence of *Toxoplasma* in tissues of experimentally infected white rats. Proc. Soc. Exper. Biol. & Med. 76: 793–796 (1951).

(*13*) Jacobs, L., Melton, M. L., and Cook, M. K.: Observations on toxoplasmosis in dogs. J. Parasitol. 41: 353–361 (1955).

(*14*) Jacobs, L., Melton, M. L., and Cook, M. K.: Experimental toxoplasmosis in pigeons. Exper. Parasitol. 2: 403–416 (1953).

(*15*) Kass, E. H., Andrus, S. B., Adams, R. D., Turner, F. C., and Feldman, H. A.: Toxoplasmosis in the human adult. Arch. Int. Med. 89: 759–782, May 1952.

(*16*) Lainson, R: Toxoplasmosis in England. II. Variation factors in the pathogenesis of *Toxoplasma* infections: The sudden increase in virulence after passage in multimammate rats and canaries. Ann. Trop. Med. Parasitol. 49: 397–416 (1955).

(*17*) Erichsen, S., and Harboe, A.: Toxoplasmosis in chickens. 1. An epidemic outbreak of toxoplasmosis in a chicken flock in south-eastern Norway. Acta. path. et microbiol. Scandinav. 33: 57–71 (1953).

(*18*) Mello, U.: Un cas de toxoplasmose du chien observé à Turin. Bull. Soc. path. exot. 3: 359–363 (1910).

(*19*) Habegger, M.: Le réservoir biologique animale et sa relation avec l'infection toxoplasmique humaine. Geneva, Switzerland. Ambilly-Annemasse, Imprimerie Franco-Suisse, 1953, 115 pp.

(*20*) Miller, L. T., and Feldman, H. A.: Incidence of antibodies for toxoplasma among various animal species. J. Infect. Dis. 92: 118–120 (1953).

(*21*) Siim, J. C.: Epidemiological aspects of toxoplasmosis. *In* Transactions of the 6th International Congress of Pediatrics. Zurich, 1950, pp. 365–366.

(22) Morris, J. A., Aulisio, C. G., and McCown, J. M.: Serological evidence of toxoplasmosis in animals. J. Infect. Dis. 98: 52–54 (1956).

(23) Lainson, R.: Toxoplasmosis in England. III. *Toxoplasma* infection in dogs: The incidence of complement-fixing antibodies among dogs in London. Ann. Trop. Med. & Parisitol. 50: 172–186 (1956).

(24) Westphal, A., and Finke, L.: Der Hund als epidemiologischer Faltor der Toxoplasmose des Menchen. Ztschr. f. Tropenmed. v. Parasitol. 2: 236–239 September 1950.

(25) Prior, J. A., Cole, C. R., Docton, F. L., Saslaw, S., and Chamberlain, D. M.: Toxoplasmosis. IV. Report of 3 cases with particular reference to asymptomatic *Toxoplasma* parasitemia in a young woman. Arch. Int. Med. 92: 314–320 (1953).

(26) Potts, R. E., and Williams, A. A.: Acute myocardial toxoplasmosis. Lancet 270: 483 (1956).

(27) Cathie, J. A. B.: Myocardial toxoplasmosis. Lancet 268: 149 (1955).

(28) Otten, E., Westphal, A., and Kajahn, E.: Zur Epidemiologie der Toxoplasmose: der Hund also Infektionsquelle des Menschen. Klin. Wchnschr. 29: 343–346 (1951).

(29) Nicolle, C., and Conor, M.: La toxoplasmose du gondi. Bull. Soc. path. exot. 6: 160–165 (1913).

(30) Boez, L.: Schizogonie et lesions pulmonaires dans un cas de toxoplasmose spontanée du chien. Compt. rend. Soc. de biol. 85: 479–484 (1921).

(31) Laveran, A., and Marullaz, M.: Recherches expérimentales sur le *Toxoplasma gondii*. Bull. Soc. path. exot. 6: 460–468 (1913).

(32) Chamberlain, D. M., Docton, F. L., and Cole, C. R.: Toxoplasmosis. II. Intra-uterine infection in dogs, premature birth and presence of organisms in milk. Proc. Soc. Exper. Biol. & Med. 82: 198–200 (1953).

(33) Seibold, H. R., and Hoerlein, B. F.: Subclinical canine distemper with renal toxoplasmosis. J. Am. Vet. M. A. 127: 226–228 (1955).

(34) Feldman, H. A., and Miller, L. T.: Serological study of toxoplasmosis prevalence. Am. J. Hyg. 64: 320–335, November 1956.

(35) Jacobs, L., and Melton, M. L.: The distribution of *Toxoplasma gondii* in the muscles of rats with chronic infections (abstract). J. Parasitol. 43 (suppl.): 41–42, October 1957.

(36) Sanger, V. L., and Cole, C. R.: Toxoplasmosis. VI. Isolation of *Toxoplasma* from milk, placentas, and newborn pigs of asymptomatic carrier sows. Am. J. Vet. Research 16: 536–539 (1955).

(37) Momberg-Jorgensen, H. C.: Toxoplasmosis in pigs. Nord. Vet-Med. 8: 227–238 (1956).

(38) Weinman, D., and Chandler, A. H.: Toxoplasmosis in swine and rodents. Reciprocal oral infection and potential human hazard. Proc. Soc. Exper. Biol. & Med. 87: 211–216 (1954).

(39) Weinman, D., and Chandler, A. H.: Toxoplasmosis in man and swine. An investigation of the possible relationship. J. A. M. A. 161: 229–232 (1956).

(40) Jacobs, L., Cook, M. K., and Neumann, E.: Serologic survey data on the prevalence of toxoplasmosis in the Jewish population of New York. J. Parasitol. 40: 701–702 (1954).

(41) Wright, W. H., Kerr, K. B., and Jacobs, L.: Studies on trichinosis. XV. Summary of the findings of *Trichinella spiralis* in a random sampling and other samplings of the population of the United States. Pub. Health Rep. 58: 1293–1313, Aug. 27, 1943.

(42) Jacobs, L., and Melton, M. L.: A procedure for testing meat samples for *Toxoplasma*, with preliminary results of a survey of pork samples. J. Parasitol. 43 (suppl.): 38–39, October 1957.

Grants for Health Research Facilities

To encourage expansion of the Nation's health research facilities, the Public Health Service has approved 100 grants for the fiscal year 1958, on the recommendation of the National Advisory Council on Health Research Facilities. The grants, totaling more than $26 million, were awarded to 77 institutions, including hospitals, universities, research institutes, and schools of medicine, dentistry, and public health in 30 States and the District of Columbia.

The awards open the second phase of a 3-year program authorized by the 84th Congress. Each year the program receives $30 million "to assist in the construction of facilities for research in medicine, osteopathy, dentistry, and public health, and in fundamental and applied sciences when related thereto."

A total of 109 research facility grants to institutions in 31 States was previously awarded under the appropriations for fiscal 1957.

A Survey of X-Radiation Exposure *in the* Practice of Veterinary Medicine

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THE occasional appearance among veterinarians of cases of radiation exposure resulting in permanent disability of the hands has given rise to considerable speculation concerning the role of radiation as an occupational hazard of that profession. Nowhere have we seen this conjecture supported by a systematic study of actual radiation exposure conditions encountered in the practice of veterinary medicine. In keeping with the established program and policies of the radiological health program of the New Jersey State Department of Health this study has been developed to meet this need.

We did not construct our sample of New Jersey's veterinary population with an objectivity that would warm the heart of a rigorous biostatistician. We simply wrote to the approximately 350 licensed veterinarians in the State, described the field survey we wished to make, and invited their participation. We received favorable replies from 61 animal hospitals. We have no way of knowing the exact number of veterinary X-ray installations in New Jersey, but we have fair reason to believe that 61 represents about one-half. If the 61 typify the profession with respect to X-ray usage, then our survey findings will be representative of prevalent conditions. It is necessary to express a word of caution in this respect. It is quite possible that those who replied may be the ones who are most apprehensive of the harmful effects of radiation; they consequently may use radiation equipment less frequently and with more caution than the veterinary population as a whole. To the extent that this is true our estimates of radiation exposure will be in error and, unfortunately, not in a conservative direction.

One advantage of this invitation approach to the survey was that all of the participants were happy to see us and were cooperative and hospitable. Many were amazed that the New Jersey State Department of Health offered such a service. All inquiries were answered frankly, even such questions as, "I see you have leaded aprons and gloves, Doctor, but do you wear them?"

In all, we visited 54 animal hospitals out of the 61 replying. The facilities are used by about 90 veterinarians. Our survey personnel made joint visits to the first six hospitals to assure the use of standard procedures in later surveys. We sought in these visits information on the type of X-ray facilities used, the

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frequency and manner of their use, protective devices and techniques, and the expected radiation exposure of the veterinarian and his assistants.

Facilities and Their Use

Of the 54 animal hospitals surveyed, 33 use radiographic X-ray alone, that is, no fluoroscopy. The majority of the veterinarians visited have fluoroscopic equipment also but never use it. The principal reason given for disuse was fear of excessive radiation exposure. Some men also asserted the value of having a permanent record of all radiographic examinations. Eight of the 54 hospitals use fluoroscopy only. Veterinarians at those hospitals praised the versatility of fluoroscopy and the saving of the time and expense required for taking and developing X-ray pictures. The remaining 13 hospitals employ both techniques.

Only two of the hospitals surveyed use the X-ray machine for therapy, but several other veterinarians expressed the intention of employing their equipment for this purpose in the near future.

About three-quarters of the X-ray units surveyed have a maximum current setting of 15 milliamperes and a peak voltage setting of 80 kilovolts. Three machines have unvariable settings. The remainder, consisting generally of newer machines, permit either 30 ma. or 50 ma. maximum current.

Only one hand fluoroscope was discovered. Happily that murderous device is retained by its owner for its antiquarian value only.

We have estimated from the data given us that the average frequency of use of the X-ray machine by veterinarians in this study is about 5 times a week. The average use of fluoroscopy is probably 2 to 3 times a week, with a weekly viewing time of perhaps 20 to 30 seconds. Far beyond all other factors, infrequent use of the equipment tends to keep veterinarians' exposure to radiation within accepted limits. Many of the techniques observed, if employed by a full-time radiologist or in a busy X-ray clinic, would create gross overexposure of personnel. If the X-ray usage by any veterinarian substantially exceeds the average found in this study, then, of course, he is more likely to receive greater exposure.

Protective Devices

All but two of the veterinarians visited have leaded aprons and gloves. About one-fourth, however, admitted that they seldom if ever wear them. Many times only one apron is available even though both the veterinarian and an assistant are simultaneously exposed. The gloves are worn less frequently than the apron. The veterinarians asserted that the bulkiness of leaded gloves makes positioning of a small animal, and palpation during fluoroscopic examination, difficult if not impossible.

In approximately one-fourth of the installations surveyed, a partially or completely lead-shielded cabinet is provided below the table to house the X-ray tube during fluoroscopy. The remaining three-fourths of the hospitals visited use an unshielded cabinet or, more frequently, an ordinary open table. In five study cases the veterinarian has provided himself with a lead shield behind which he stands when the machine is in operation. In only one instance is the X-ray remotely operated from a fully shielded control room.

One-fifth of the machines surveyed either have no external cone, or the cone used is so large that it is completely ineffectual from the point of view of protection. The principal reason for coning in most X-ray installations is to prevent avoidable scatter which tends to fog the X-ray film. However, under the conditions of use that prevail in most veterinarians' offices, coning is of considerable importance in minimizing radiation exposure to the operator. The difference in exposure with and without proper coning is described under the category "exposure estimate."

Somewhat the same point can be made concerning X-ray filters; they are useful in preventing unnecessary exposure to the operator although this is not usually their essential purpose. A filter removes from the useful beam X-rays of such low energies that they will not penetrate tissue to reach the film anyway. In X-raying humans, filtration is employed to limit useless exposure of the patient. In veterinary radiography, filtration reduces exposure of the operator since he is close to and occasionally within the direct beam. X-ray tubes possess some inherent filtration, a quantity we were unable to measure. For the great

majority of X-ray tubes inherent filtration is not adequate. We are inclined to recommend the addition of a least 1 mm. aluminum external filtration for all tubes.

In 2 of the 21 survey hospitals that use fluoroscopy, a leaded rubber curtain, suspended from the screen to the table top, shields the viewer from scatter radiation.

Techniques

The great majority of veterinarians anesthetize most of the animals before X-raying them. In many instances, however, anesthesia is omitted if a picture is to be made of an extremity of a docile, controllable animal. Neither is it used when the animal's health is considered too precarious to support the toxic effects of the anesthetic. In some of these latter instances the animal is narcotized. These practices simplify but do not eliminate the holding of the subject in the hand. Even if the animal is asleep or narcotized, in almost all cases someone holds it in the proper position for the desired picture. A small minority of the veterinarians use sandbags and other props for positioning the animal. Some men request the owner to hold the cat or dog, on the theory that one-time exposure for the owner is far less objectionable than repeated exposure for the veterinarian and his technician or handler. Of course, in many instances the animal is left at the doctor's office for diagnosis and treatment, and the owner is not present when the X-ray is taken. The majority of animals are manually positioned by the veterinarian or his employee.

One disturbing observation made in the field visits is the lack of standardization in the selection of various X-ray factors such as current, voltage, time, and distance. It is, of course, understood that some variation of these factors is possible without sacrificing picture quality but surely not to the extent encountered.

Among the veterinarians the distance from tube target to the film varies from 20 inches to 36 inches; in virtually all installations the dimension, once selected, is never varied. Differences in voltage, current, and time selections for comparable radiographs are considerable. Radiation dose delivered to animals for pictures of equivalent tissue depth may range from 100 to 500 milliroentgens. This disparity is reflected in such variation of picture quality that some operators are obviously not gaining the full advantage of X-ray as a diagnostic aid. The art of obtaining maximum picture definition and contrast is not in our province, and, generally, we scrupulously avoided offering recommendations in this connection. However, X-ray factor selection is in our field of interest when improper settings require two or more X-rays where one would suffice, and when the delivered X-ray dose is considerably larger than is required for good picture quality.

The procedure usually employed in changing the voltage and current to new settings for different tissue thicknesses makes our attempts to determine average equipment usage highly unrealistic in many cases. An X-ray machine may be operated to an extent equivalent to 4, 5, or more exposures in the process of adjusting the current and voltage to desired levels. In only three instances the operator was observed to push the X-ray tube down flush with the table surface of a completely shielded fluoroscope cabinet so as to contain radiation issued during test procedure. As mentioned earlier, many installations are not equipped with such a cabinet; in these cases testing simply adds to the weekly X-ray workload.

Exposure Estimate

In all of our regular field appraisals of radiation exposure, we are guided by the recommendations of the National Committee on Radiation Protection, published in handbooks of the National Bureau of Standards. For persons occupationally exposed, the committee has suggested a maximum permissible radiation dose of 300 mr. a week for irradiation of the whole body and 1,500 mr. a week for irradiation of the hands alone. These maximum levels are generally accepted in the field of radiological health.

On all our field visits in this study and elsewhere, we have insisted that no one should feel cheated if he does not get his allowable radiation dose for the week. All ionizing radiation produces tissue destruction; some of this destruction is irreversible. The concept sup-

porting a maximum permissible dose is that cumulative tissue damage is not likely to be appreciable in the course of a man's life if exposure is kept below this limit. However, the pathological effects of radiation are not precisely predictable. Nor can we know with any certainty in what manner or to what extent the genetic effect of radiation can or will transmute the progeny of exposed persons or, in turn, their offspring. These doubts support the contention that all unnecessary radiation exposure is excessive.

To corroborate the exposure determinations made by instrument survey, we distributed to all participating veterinarians and their technicians radiation-monitoring film badges to be worn when using the X-ray machine for, in most cases, two consecutive 1-month periods. It was our intention to obtain a measure of actual radiation dose received by veterinarians under typical operating conditions. For the time that the badges were worn, each veterinarian was requested to keep a complete record of the exposure time and factor settings on his machine. The results of the film badge project were provocative if not completely satisfactory. We feel that this useful procedure should be carried on for a longer survey period, personnel and equipment permitting.

Badges were lost. Some veterinarians neglected to wear their badges when using the X-ray machine. So much delay was encountered in getting the veterinarians to return the badges that many badge readings are considered unreliable. In all, 161 badges were processed by a commercial contractor. Allowance was made for the energy dependence of film in converting densities to radiation exposure. The following table gives the exposure in milliroentgens per month:

Milliroentgen/month range	*Number of badges*
0	64
1–100	62
100–200	14
200–500	11
500–1,000	3
1,000–2,500	3
Over 2,500	4
Total	161

The film data show that most of the veterinarians participating in this study at the time they were monitored did not receive, on the average, a weekly radiation dosage in excess of the generally accepted limit of 300 mr. Seven badges of the 161 showed a weekly exposure of more than a 300 mr. One man received a monthly dosage of 30, 1.7, and 2.5 roentgens for three consecutive months. Another man using the same machine received 2.6, 5.3, and 0.3 roentgens for the same monthly periods. Our inspection revealed that the machine had no cone and was employed to an extent considerably in excess of the average usage in this survey.

In general, we are reluctant to accept the preceding data as descriptive of exposure conditions in the practice of veterinary medicine. Since individuals often forgot to wear the badge, and in most cases when worn it was clipped near the left breast pocket, we feel that badge readings tended to indicate a minimum possible exposure. We consider the information obtained by instrument survey to be more reliable.

We made three types of radiation measurements in the instrument survey: direct beam radiation doses, scattered radiation dose in the operator's position, and radiation rate at selected sites in the vicinity of the machine. A Victoreen Condenser-R meter and a Tracerlab-SU-1F were used for these measurements.

If a man standing immediately adjacent to the X-ray table operates a properly coned X-ray tube at 70-kv. peak and 15 ma. in radiography, he will receive, on the average, scattered radiation amounting to 3–5 mr. per second. If the tube is not coned he is likely to receive 10 times this dose, or 30–50 mr. per second. If his hands are in the direct beam, they will receive approximately 250 mr. per second. If the table is not shielded and the operator stands next to it, as did the majority of the veterinarians observed, his feet are likely to be within the direct beam, receiving an exposure of approximately 50 mr. per second.

Using the X-ray without proper coning, employing an unshielded table, and holding the animal with the hands in the direct beam are the three conditions which cause the most severe exposure in veterinary radiography. If these practices were avoided, approximately

fifty 1-second exposures per week could be made before the operator's exposure reached the limit of 300 mr. It should be emphasized that these are typical values as measured in a number of veterinary radiographic installations and cannot be considered to apply to all radiographic installations, veterinary or otherwise.

In operating a fluoroscope at 60-kv. peak and 5 ma., scattered radiation in the position of the viewer is approximately 1 mr. per second. If the hands are introduced into the direct beam after subject absorption, to move or palpate the animal, they will receive a dose of about 250 mr. per second. Three veterinarians informed us that their hands had received a disabling dose of radiation. They attributed the exposure to work done in years past with bare hands under the fluoroscopic screen.

In 10 installations the inadequacy or lack of coning permitted the direct radiation beam to overlap the screen and strike the face of the viewer. In such a case approximately 2 seconds of viewing will cause radiation exposure in excess of the suggested limit for the week.

Radiation rate measurements made at the operator's knee level during fluoroscopy reveal scatter radiation of approximately 2,500 mr. per hour. For those installations with a shielded cabinet, this level is about 5 mr. per hour, indicative of a reduction by a factor of 500. Dose readings made on the operator's side of a leaded rubber curtain suspended from the fluoroscopic screen were virtually zero for 10 seconds of viewing time.

Although other radiation measurements were made for various types of machines and conditions of operation, the data gleaned are too detailed for suitable presentation in a summary report. Some mention should be made, however, of the relationship of exposure and the use of leaded aprons and gloves. It is difficult to state with any accuracy the degree of protection afforded by these garments. If they contain one-half millimeter of lead, they will reduce the high energy component of 75-kv. peak X-ray by a factor of 7 to 10. They will exclude the lowest energy component. Their net effect upon a radiation beam of mixed energies, such as is produced by an X-ray machine, is to provide a reduction in exposure by a factor of more than 100.

Any exposure an X-ray operator receives as a result of failing to wear a leaded apron is both avoidable and useless and is excessive in the purest sense of the word.

Summary Recommendations

For veterinarians employing X-ray and fluoroscopic equipment under average conditions of workload and use encountered in this survey (less than 10 milliampere-minutes per week), we have the following recommendations:

- Always wear a leaded apron when using the X-ray or fluoroscope.
- Wear leaded gloves when hands are in the vicinity of the direct beam.
- When possible, anesthetize subject animals and use props to position them for radiography.
- Restrict radiation dose to the lowest level consistent with good picture quality and screen image visibility. Dark-adaptation of the operator's eyes will aid the latter.
- House the X-ray tube in a shielded cabinet for fluoroscopy.
- Suspend a leaded rubber curtain from the fluoroscopic screen to the table top on the side where the viewer stands.
- Always use a cone or diaphragm that will restrict the useful beam to the film size used.
- Never hold the animal to be radiographed with hands in direct beam.
- Provide at least a 1-mm. aluminum external filter for all X-ray tubes.
- When testing for desired factor settings, push the X-ray tube down flush with the table surface of the shielded fluoroscope cabinet.
- Provide a cone or diaphragm for fluoroscopy that will give an unilluminated area at least one-quarter inch wide around the entire periphery of the screen. Fix the motion of the screen to the tube in order to prevent removal of the screen from the direct beam.

comparison of

COMPLEMENT FIXATION TESTS

for

coccidioidomycosis

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THE VALUE of serologic tests in the diagnosis and prognosis of coccidioidomycosis has been established in long-term studies at the University of California School of Public Health (*1*, *2*). Prognostically, a serum titer greater than 1:16 in the quantitative complement fixation test has indicated increased likelihood of dissemination of the infection. Complement-fixing titers have exceeded this "critical" level in serum samples from three-fifths of more than 700 patients with disseminated disease and from five-sixths of approximately 300 patients with extensive disseminations other than meningitis. On the other hand, in serum samples from more than 3,000 patients with primary nondisseminated disease, complement-fixing titers exceeding 1:16 have been observed in less than one-tenth.

These diagnostic and prognostic values have been determined by a single complement fixation technique. Not all laboratories, however, routinely use the same procedure. Since optimal utilization of serologic tests for coccidioidomycosis will be favored if laboratories can use, without modification, the techniques in which they are skilled (*3*), it is important to determine whether other complement fixation techniques are diagnostically applicable. In particular, it is important to learn whether they alter the prognostic use of the critical titer.

Therefore, in 1948 a study was initiated to evaluate the consistency of five techniques of complement fixation. A corollary purpose was to determine the applicability of a positive control serum standardized to approximate the

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titer critical for dissemination. Collaborating with the University of California School of Public Health in this study were the Rocky Mountain Laboratory of the Public Health Service, the Army Medical Service Graduate School (now the Walter Reed Army Institute of Research), and the Fort Miley Veterans Administration Hospital. The investigations were sponsored by the Commission on Acute Respiratory Diseases, Armed Forces Epidemiological Board, which is supported by the Office of the Surgeon General, Department of the Army.

Method of the Study

The serum samples tested were specimens sent to the University of California School of Public Health for serologic tests for coccidioidomycosis. After an initial test, appropriate specimens of sufficient volume were divided into five equal parts. Three were sent as unknowns to the collaborating laboratories and two were retained.

Serums of persons without coccidioidal disease and of patients having various clinical forms of the infection were included in each set of unknowns. Using a 1:8 dilution of lot 47–54 of the previously described antigen (*1*), each collaborating laboratory performed quantitative complement fixation tests by the method it routinely uses. The University of California tested the specimens a second time with the original technique of binding for 2 hours at 37° C. and simultaneously with 18-hour 4° C. binding. The five methods are outlined in table 1. The collaborating laboratories returned the results to the University of California for tabulation. Only specimens with four plus (++++) values were considered positive.

The study was continued for 4 years, during which time a total of 508 human serum samples were submitted to each collaborator. These were derived from a group of 18,500 specimens (*2*) with serologic patterns similar, except for slightly higher titers in all varieties of the infection, to those of the 21,000 specimens described in the initial report (*1*). Unfortunately, many tubes were broken or the serums became anticomplementary during transit. Consequently, the numbers actually tested by the different methods varied. However, a total of 206 specimens were tested by all five methods.

Specificity

Forty of the 508 specimens were from individuals known not to have coccidioidal infection. Seventeen were satisfactorily tested by all five methods. Only a single specimen was reported as positive by one laboratory (titer, 1:256).

Comparison of Titers

The comparison of titers obtained with the various techniques of complement fixation is based on analysis of the 206 serum samples tested by all five methods.

Table 1. Methods used by collaborating laboratories in performing complement fixation tests for coccidioidomycosis

Laboratory	Number of units of complement	Binding		Hemolytic system		
		Time (hours)	Temperature (degrees centigrade)	Time (hours)	Temperature (degrees centigrade)	End point (percent)
University of California [1]	2	2	37	1	37	100
University of California	2	18	4	1	37	100
Rocky Mountain Laboratory	2	1	37	1	37	100
Fort Miley Veterans Administration Hospital	4	18	4	½	37	50
Army Medical Service Graduate School	3	18	4	½	37	50

[1] The method also of the initial test, references 1 and 2.

Table 2. Factors of comparison and percentage agreement among five methods of coccidioidal complement fixation

Method	Factor of comparison	Percentage agreement
U. of C. 2-hr. 37° C. with original U. of C. 2-hr. 37° C.	Same	94
U. of C. 2-hr. 37° C. with U. of C. 18-hr. 4° C.	2-fold increase.	93
U. of C. 2-hr. 37° C. with RML 1-hr. 37° C.	2-fold increase.	88
U. of C. 2-hr. 37° C. with Fort Miley 18-hr. 4° C.	2-fold increase.	76
U. of C. 2-hr. 37° C. with Army 18-hr. 4° C.	5-fold increase.	88
U. of C. 18-hr. 4° C. with Fort Miley 18-hr. 4° C.	Same	80
U. of C. 18-hr. 4° C. with Army 18-hr. 4° C.	2½-fold increase.	88

The results of the original test and those of the repeat test at the University of California using the 2-hour 37° C. technique show agreement of 94 percent when the usual allowance is made for a variation of one serial dilution. However, even this difference demonstrates the importance of repeating the complement fixation test of a previous specimen concurrently with a new specimen. Otherwise, prognostically significant changes may be wrongly inferred.

Comparison of the simultaneous tests with 2-hour 37° C. binding and with 18-hour 4° C. binding at the University of California indicates a consistent shift one serial dilution higher in the latter. Again there is agreement of 94 percent within a one-serial-dilution variation.

The 1-hour 37° C. technique of the Rocky Mountain Laboratory also produces titers one serial dilution higher than those of the University of California's 2-hour 37° C. method. For these two methods, agreement is 88 percent when a variation of one serial dilution is allowed.

The method of the Fort Miley Veterans Administration Hospital, in which 18-hour 4° C. binding and four 50-percent units of complement are used, results in slightly greater scattering of titers than the 2-hour 37° C. method. A relatively large number of specimens found positive by other methods were negative by the Fort Miley technique. Nevertheless, agreement at one serial dilution higher than the University of California's values is 76 percent.

Use of three 50 percent units of complement and an overnight period at 4° C. for fixation, the method of the Army Medical Service Graduate School, results in titers 5 times higher than the University of California's two 100-percent units of complement and 2-hour 37° C. binding. Agreement between these two techniques is 88 percent.

Since the Fort Miley and the Army techniques both include 18-hour icebox binding, the results obtained with these two methods have been compared with those obtained with similar

Table 3. Percentage distribution of maximal complement-fixing titers in serums of patients with primary coccidioidal infection: comparative results of six tests

Maximal titer of complement fixation, other than Army	U. of C. 2-hr. 37° C., concurrent series (percent of 1,365 patients)	U. of C. 2-hr. 37° C. (percent of 109 patients)	U. of C. 18-hr. 4° C. (percent of 142 patients)	RML (percent of 103 patients)	Fort Miley (percent of 84 patients)	Maximal titer of complement fixation, Army	Army (percent of 112 patients)
2	42	46	13	26	27	5	18
4	23	22	27	29	26	10	23
8	16	14	28	15	23	20	30
16	10	11	15	10	10	40	13
32	7	2	13	10	8	80	9
64	1	3	1	4	3	160	5
128	1	1	2	2	2	320	1
256	(0. 3)	1	1	4	1	640	1
<32	**91**	93	83	80	86	<80	84
<64	98	**95**	**96**	**90**	**94**	<160	**93**

Table 4. Percentage distribution of maximal complement-fixing titers in serums of patients with coccidioidal pulmonary residuals (with and without cavities): comparative results of six tests

Maximal titer of complement fixation, other than Army	U. of C. 2-hr. 37° C., concurrent series (percent of 384 patients)	U. of C. 2-hr. 37° C. (percent of 47 patients)	U. of C. 18-hr. 4° C. (percent of 48 patients)	RML (percent of 40 patients)	Fort Miley (percent of 31 patients)	Maximal titer of complement fixation, Army	Army (percent of 41 patients)
2	56	49	35	38	39	5	10
4	25	26	23	18	29	10	22
8	10	13	21	10	20	20	27
16	6	6	10	22	6	40	19
32	3	6	9	8	6	80	17
64	0	0	2	2	0	160	2
128	0	0	0	2	0	320	3
256	0	0	0	0	0	640	0
<32	**97**	**94**	89	88	94	<80	85
<64	100	100	**98**	**96**	**100**	<160	**97**

fixation at the University of California. The latter, as one recalls, yields titers one serial dilution higher than does the standard 2-hour 37° binding. Also, the titers at Fort Miley are one serial dilution higher than those of the University of California's standard technique. Thus, it would be expected that the Fort Miley test and the University of California's overnight test would produce titers of the same level. This assumption has been found to be correct, with an agreement of 80 percent. By the same reasoning, results of the Army test should correlate with the results of the University of California overnight, icebox binding at a 2½-fold increase in titer. This, too, has been found to be true, with the excellent agreement of 88 percent.

The factors of comparison for the various techniques, together with the degree of agreement, are summarized in table 2.

Comparison of Prognostic Applications

As previously noted, experience at the University of California with the 2-hour 37° C. technique of binding complement has indicated that 1:16 is the titer critical for disseminated coccidioidal infection. The present study has shown that the results of four other techniques are consistently comparable with the results of the 2-hour 37° C. procedure. By use of the factors of comparison given in table 2, the "equivalent" critical titers for these four techniques are estimated to be as follows:

University of California 18-hour 4° C	1:32
Rocky Mountain Laboratory 1-hour 37° C	1:32
Fort Miley 18-hour 4° C	1:32
Army 18-hour 4° C	1:80

The maximal titers of complement fixation in the serums from individual patients with primary coccidioidal infection are compared in table 3. The numbers tested by the different methods vary because of unsatisfactory (broken or anticomplementary) specimens. If multiple specimens from the same patient are included in the comparisons, only the maximal titer is indicated. Also shown in this table are the results of the entire series of specimens from patients with primary infection (designated "concurrent series") from which the samples for the comparisons were obtained. The cumulative percentage distributions at the respective critical titers indicate that these levels consistently include between 90 and 96 percent of the patients' serums.

Correlation among the five techniques for fixing complement is close also for patients with coccidioidal pulmonary residuals (with or without cavities), as shown in table 4. The previously reported studies revealed that serums of patients with this form of the infection fix complement at titers even lower than do those of patients with primary infection. In the present study, from 94 to 100 percent of the

patients' serums are no higher than the equivalent critical titers.

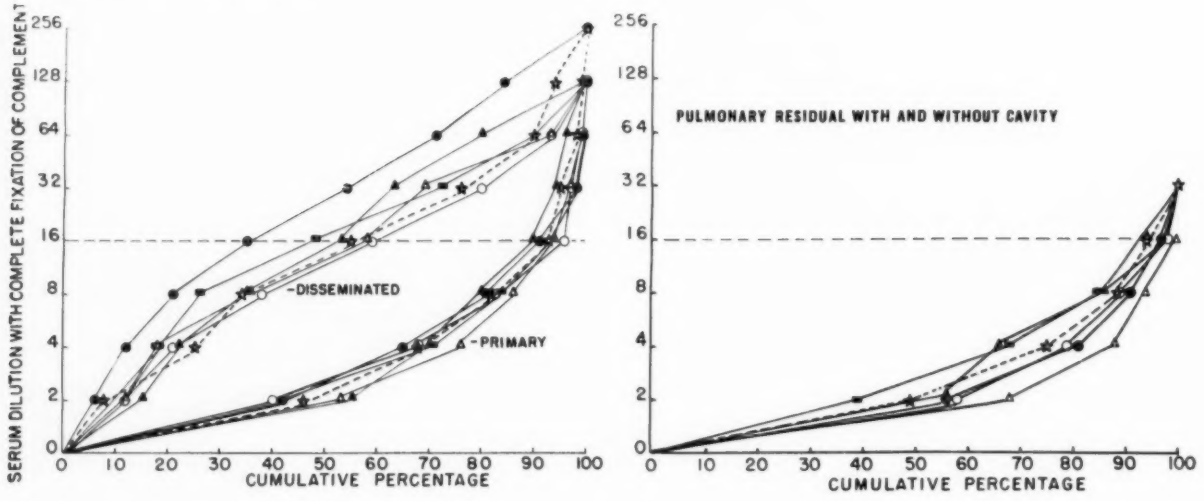
The characteristically high titers of complement fixation in serums of patients with disseminated disease are shown in table 5. The critical titers are exceeded in from 41 to 52 percent of the patients' serums.

The accompanying illustration shows the

Table 5. Percentage distribution of maximal complement-fixing titers in serums of patients with disseminated coccidioidal infection: comparative results of six tests

Maximal titer of complement fixation, other than Army	U. of C. 2-hr. 37° C. concurrent series (percent of 300 patients)	U. of C. 2-hr. 37° C. (percent of 66 patients)	U. of C. 18-hr. 4° C. (percent of 67 patients)	RML (percent of 60 patients)	Fort Miley (percent of 55 patients)	Maximal titer of complement fixation, Army	Army (percent of 50 patients)
2	6	8	3	10	7	5	2
4	6	17	9	5	5	10	4
8	9	9	9	7	6	20	12
16	14	21	17	13	18	40	8
32	19	21	21	18	22	80	22
64	17	14	21	10	11	160	24
128	13	6	13	17	24	320	18
256	16	4	7	20	7	640	10
<32	**35**	**55**	38	35	36	<80	26
<64	54		**59**	**53**	**58**	<160	**48**

Cumulative percentage distributions of maximal complement-fixing titers for three types of coccidioidal infection: results of four methods adjusted to equivalence with the University of California 2-hour 37° technique.



		Number of patients		
		Primary	*Disseminated*	*Pulmonary residual*
●——●	U. of C. 2-hr. 37° C., concurrent series	1,365	300	384
☆- - -☆	U. of C. 2-hr. 37° C., comparative series	109	66	47
○——○	U. of C. 18-hr. 4° C., comparative series	142	67	48
▲——▲	RML 1-hr. 37° C., comparative series	103	60	40
△——△	Fort Miley 18-hr. 4° C., comparative series	84	55	31
■——■	Army 18-hr. 4° C., comparative series	112	50	41

cumulative percentage distributions of the maximal titers for the three categories of patients when the results of the four other methods are adjusted to equivalence with the results of the University of California 2-hour 37° C. procedure. In each category, all the distribution curves are remarkably similar. This finding further demonstrates that results obtained by a variety of complement fixation techniques are comparable, provided an index of equivalence can be devised. The contrast in the patterns of the curves in the nondisseminated and the disseminated infections also can be seen in this illustration.

For patients with disseminated disease, the titers of the comparative tests are not quite as high as those of the total concurrent series. A possible reason for this discrepancy is that specimens for the comparative study frequently have been selected from patients with earlier positive specimens. Although only the maximal titer is selected for a single patient, such repeat specimens characteristically come from less severely ill patients. Unfortunately, the volume of serums sent us from seriously ill patients who die of fulminating disease has been too small to permit use of these serums in the comparative tests. Thus the comparative series is weighted by patients with less severe disease whose serums have lower titers.

Standard Positive Control Serum

Laboratories performing complement fixation tests for coccidioidomycosis require a positive control serum. One feasible method for comparing the results of different techniques would be to have this positive control standardized at the critical level. Accordingly, Cutter Laboratories was supplied with suspensions of multiple strains of *Coccidioides immitis* in the mycelial phase. A series of horses was infected intravenously. After precipitin and complement-fixing antibodies had developed, the serums were harvested and pooled. Various dilutions were made with normal horse serum and, together with normal horse serums, sent out under fictitious names as part of the comparative testing of human serums.

The results obtained with the five complement fixation techniques are summarized in table 6. Regardless of the method employed, the pooled horse serums diluted 1:4 approximate the critical titer. Each of the five sets of normal horse serums has been negative. Thus the objective of a standardized positive control serum appears to have been achieved. Bieberdorf (*4*), recognizing the necessity of a positive control serum for coccidioidal complement fixation, has proposed the use of lyophilized serum from infected rabbits. Use of the positive control serum in combination with the critical titer to provide an index of equivalence, as discussed above, appears more desirable. Also, a larger volume of appropriately standardized positive serum can be obtained from the horse.

Table 6. Titers obtained on various dilutions of horse serums by collaborating laboratories

Dilution of serum	U. of C. 2-hr. 37° C.	U. of C. 18-hr. 4° C.	RML	Fort Miley	Army
	Range of titers				
Undiluted	32–256	64–256	128–256	64–256	640–1280
2	16–64	32–128	32–128	32–64	160–640
4	**8–32**	**32–128**	**16–32**	**32**	**80**
8	4–16	8–16	2–16	2–8	40–80
16	2–8	4–8	4–16	4	20
32	0–4	2–4	0–4	0	10
64	2	4	2	------	10
128	0	2	2	------	5
256	0	0	0	0	0
	Modal titer				
Undiluted	64	128	128	128	320
2	32	64	32	64	160
4	**16**	**32**	**32**	**32**	**80**
8	8	16	16	8	40
16	4	8	8	4	20
32	2	4	4	2	10
64	0	2	2	0	5
128	0	0	0	0	0
256	0	0	0	0	0

Although Bieberdorf discusses the relative merits of the specificity of coccidioidal rabbit serum with antigens of *Histoplasma* and *Blastomyces*, we believe that specificity in a serum control is not a primary consideration. The control is to be used in tests with coccidioidin as the only antigen. Thus the results will relate only to the titers of the serums that are tested with this substance. Campbell and

Salvin have both found markedly strong cross reactions in the horse serums when they use antigens of *Histoplasma capsulatum* and *Blastomyces dermatitidis*. However, these findings relate to the lack of specificity of these two heterologous antigens. The testing of human serums is a wholly different matter. In these complement fixation tests coccidioidin appears to have a relatively high degree of specificity. Nevertheless, as discussed earlier (*2*, *5*), cross reactions in human serums should be kept in mind.

To investigate further the practicality of the general use of complement fixation tests for coccidioidomycosis, a second study with eight additional collaborating laboratories is now under way. Only 2 of the 13 complement fixation methods are alike. Thus this study is investigating not only the variations of complement fixation results which may be encountered but also the degree of consistency and reproducibility of the comparative values and whether the control horse serum can be successfully lyophilized at a standardized critical titer.

Summary

A study of five different techniques for performing quantitative complement fixation tests for coccidioidomycosis by four laboratories has revealed indexes of comparability. When these factors of equivalence are applied to the results of the complement fixation tests in various clinical types of coccidioidal infection, the titers follow the characteristic distribution curves of nondisseminated and disseminated infections irrespective of the technique used. The consistency of the results indicates that the quantitative complement fixation tests have general prognostic as well as diagnostic applicability. An appropriately diluted serum from infected horses appears to set a "critical titer" above which dissemination is frequent and at and below which it is infrequent by whatever method is used. The investigation is now being extended to a larger number of laboratories.

REFERENCES

(*1*) Smith, C. E., Saito, M. T., Beard, R. R., Kepp, R. M., Clark, R. W., and Eddie, B. V.: Serological tests in the diagnosis and prognosis of coccidioidomycosis. Am. J. Hyg. 52: 1–21, July 1950.

(*2*) Smith, C. E., Saito, M. T., and Simons, J. A.: Pattern of 39,500 serologic tests in coccidioidomycosis. J. A. M. A. 160: 546–552, Feb. 18, 1956.

(*3*) Kessel, J. F., Yeaman, A., and Holtzwart, F.: Mycoses encountered in the Pacific southwest area of the United States of North America. New Zealand Med. J. 48: 346–356, August 1949.

(*4*) Bieberdorf, F. W., and Chambliss, K. W.: A positive test for coccidioidin complement fixation. Pub. Health Rep. 70: 771–774, August 1955.

(*5*) Campbell, C. C., and Binkley, G. E.: Serologic diagnosis with respect to histoplasmosis, coccidioidomycosis, and blastomycosis and the problem of cross reactions. J. Lab. & Clin. Med. 42: 896–906, December 1953.

DOCUMENTATION NOTE

Seven tables presenting comparative results of the five methods of complement fixation have been deposited as document No. 5358 with the American Documentation Institute Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D. C. A photoprint copy may be obtained by remitting $1.25; a 35-mm. microfilm copy by remitting $1.25. Cite document number. Advance payment is required. Make checks or money orders payable to Chief, Photoduplication Service, Library of Congress.

Prevention of Secondary Attacks of Rheumatic Fever

WILLIAM J. ZUKEL, M.D.

BASIC research into the etiology and pathogenesis of rheumatic fever is still urgently needed, since it is from such knowledge that ultimate control of the disease will be possible. However, one of our greatest practical problems in rheumatic fever prevention is not a lack of preventive measures, but rather a lack of effective application of available preventive measures.

Many physicians have the impression that rheumatic fever is no longer an important health problem in the United States. They do not see many cases in their practice—the classical manifestations of rheumatic fever are less common than a decade ago and the symptoms may be so mild that they may pass unnoticed. Therapeutic measures have also become more effective so that fewer deaths result even from the more severe attacks.

This is encouraging progress, but a look at some facts will reveal that much effort is still needed to control this largely preventable disease (table 1).

In 1954, 1,297 deaths were reported from acute rheumatic fever and rheumatic carditis. Another 18,256 deaths resulted from the effects of chronic rheumatic heart disease. This contrasts with poliomyelitis which resulted in 1,368 deaths during that year. Like poliomyelitis, rheumatic fever is largely a crippling disease, and its impact results mainly from chronic disability and, later, death from chronic rheumatic heart disease. Certainly, more than 19,000 deaths each year from the acute and chronic effects of rheumatic fever leave little room for complacency. Every State in the United States reported deaths from rheumatic fever and rheumatic heart disease in 1955. The age-adjusted death rates from rheumatic fever and rheumatic heart disease are as high in some southern States as in some northern States. However, in general, the death rates are higher in the Rocky Mountain areas, New England, and the Middle Atlantic States.

In approximately 30 States, rheumatic fever is a reportable disease. But if we considered the number of reported cases as a true index of the actual number occurring, we would be greatly misled. For example, a comparison of the reported deaths from acute rheumatic fever and rheumatic carditis (table 1) with the total number of reported cases of rheumatic fever (see below) during the years 1949 through 1955 would imply a fatality rate ranging from approximately 50 to 30 percent. This obviously is not consistent with clinical experience.

Year	*Number of cases*
1949	4,457
1950	3,635
1951	3,883
1953	3,642
1954	4,230
1955	3,690

SOURCE: Worksheets, National Office of Vital Statistics.

Dr. Zukel is assistant director of the National Heart Institute, Public Health Service. His review was prepared while he was chief of Operational Research, Heart Disease Control Program, and was presented at the annual meeting of the Staff Conference of Heart Associations, 29th Annual Scientific Sessions of the American Heart Association, Cincinnati, Ohio, October 1956.

Table 1. Deaths from poliomyelitis, acute rheumatic fever and rheumatic carditis, and rheumatic heart disease, United States

Year	Poliomyelitis (080)	Acute rheumatic fever and rheumatic carditis (400–402)	Chronic rheumatic heart disease (410–416)
1949	2, 720	2, 304	20, 434
1950	1, 904	1, 924	20, 392
1951	1, 551	1, 648	19, 988
1952	3, 145	1, 583	19, 754
1953	1, 450	1, 523	19, 587
1954	1, 368	1, 297	18, 256
1955	1, 043	1, 150	18, 760

NOTE: Numbers in parentheses are from the International Lists of Diseases and Causes of Death, sixth revision.
SOURCE: National Office of Vital Statistics, Public Health Service.

Rather, it probably indicates a large under-reporting of rheumatic fever cases. Perhaps a better indication of the under-reporting of rheumatic fever can be seen from a recently reported Minnesota study (*1*). The results of this survey are shown in table 2.

Approximately 200 cases of rheumatic fever were reported yearly by physicians in that State during 1950–54. In 1955 the Minnesota Department of Health and the Minnesota Heart Association conducted a special letter survey, asking each physician how many cases of active rheumatic fever he had treated during the preceding 12 months. The physicians reported that they had treated 2,297 cases during 1955. Although the accuracy of diagnosis was not verified, this is 10 times the number actually reported in previous years and is more than half the total number officially reported from over 30 States during that year.

The prevalence of rheumatic heart disease is not known, but it is conservatively estimated that approximately 1 million persons in the United States have been afflicted by this disease. Selected surveys of school children since 1945 have revealed a prevalence of rheumatic heart disease ranging from 0.2 to 4.6 percent of those examined (*2, 3*). The statewide survey of sixth grade Colorado school children by Maresh, Dodge, and Lichty revealed that 0.67 percent have rheumatic heart disease (*4*).

In about 1½ million registrants between the ages of 18–25 examined by the Selective Service System in the years 1940–1944, 1.8 percent were found to have rheumatic heart disease or valvular heart disease (*5*).

A recent careful clinical study of a random sample of the adults in Framingham, Mass., a community of approximately 30,000 population, has revealed a prevalence of rheumatic heart disease in 2.4 percent of the population 30–39 years of age (*6*).

Surveys of college students (*7*) have found somewhat under 1 percent with rheumatic heart disease (table 3).

The American College Health Association and the Heart Disease Control Program of the Public Health Service began a cooperative study in the fall of 1956 to determine the trend of prevalence of rheumatic heart disease among entering freshman students. Student health service physicians of 132 colleges and universities are participating in this study. Preliminary data relating to a previous history of rheumatic fever and results of entrance physical examinations are now available for 65 colleges, representing 54,058 freshman students. A previous history of definite rheumatic fever was elicited in 1.2 percent of the students. An additional 0.9 percent had a history consistent with previous possible rheumatic fever.

Physical examination findings considered to be adequate for a diagnosis of definite rheumatic heart disease were present in 0.3 percent of entering freshmen. An additional 0.6 percent had findings diagnosed as probable rheumatic

Table 2. Minnesota rheumatic fever experience, 1950–55

Year	Number cases reported	Number receiving prophylaxis
1950 [1]	162	----------
1951 [1]	170	----------
1952 [1]	221	----------
1953 [1]	235	----------
1954 [1]	148	----------
1955 [2]	2, 297	3, 323

[1] Cases reported yearly to Minnesota Department of Health.
[2] Special mail survey (*1*).

heart disease. It is hoped that continuation of this study for the next few years will provide an index of the trend of prevalence of rheumatic heart disease in this selected population group.

Community Prophylaxis

Many studies in the past two decades have emphasized the relationship between beta hemolytic streptococcal infections and the subsequent development of rheumatic fever (*8*, *9*). The number of reported cases of scarlet fever and streptococcal sore throat has actually increased in the last 5 years in the United States as shown below:

Year	*Number of cases*
1949	87,220
1950	64,494
1951	84,151
1952	113,677
1953	132,935
1954	147,785
1955	147,502

SOURCE: Reported cases of specified notifiable diseases: United States 1945–54. Data for 1955 from prepublication worksheet, National Office of Vital Statistics.

Practicing physicians and health officers should be alert to recognize outbreaks of streptococcal infections since effective measures for their treatment are now available. The need for community prophylaxis of streptococcal infections was pointed up by the recent resolution of the Association of State and Territorial Health Officers "That trials and further study of the use of penicillin in mass prophylaxis for the control of an outbreak of streptococcal infections be encouraged" (*10*). An excellent report of the experience in the prophylaxis of civilian streptococcal outbreaks in New York State has been made by Poskanzer and associates (*11*).

Prompt treatment of such streptococcal infections can largely prevent the subsequent development of rheumatic fever. The youngster who has had one attack of rheumatic fever is especially susceptible to recurrences if new streptococcal infections develop. Continuous prophylaxis with penicillin or sulfonamides is indicated for children with a known history of rheumatic fever since the risk of recurrence is as high as 50 percent following such streptococcal infections, as shown in table 4 (*12*). Many streptococcal infections go undetected, however, and the first indication of trouble may be in the actual flareup of a new attack of rheumatic fever.

The classic study which reveals the risk of recurrent attacks of rheumatic fever and the natural history of the disease was done by Dr. E. F. Bland and the late Dr. T. Duckett Jones (*13*).

One thousand children who had had rheumatic fever were followed carefully for 20 years during the era before sulfa and penicillin prophylaxis. Approximately 20 percent of the children had a recurrent attack of rheumatic fever each year in the first 5 years from the date of the initial attack. Approximately 10 percent had recurrent attacks each year during the next 5 years, 5 percent in the third 5 years, and 1.5 percent in the last 5 years. Evidently the risk of recurrence is especially high in the years immediately following the initial attack, but attacks can occur at any time. Eighty percent of the deaths during this period were caused by recurrent attacks of rheumatic fever. This and other important studies support the strong recommenda-

Table 3. Reported prevalence of rheumatic heart disease in college students [1]

Source	University	Number examined	Percent with rheumatic heart disease
Lee (1915)	Harvard students.[2]	662	1.5
Paul and Leddy (1932).	Yale students [2]	7,914	.8
	Yale students [2]	4,455	1.1
Wood (1932)	University of Pennsylvania.	3,086	1.0
Hedley (1938)	86 universities	104,163	1.2
	14 universities	46,098	.6
Cole (1941)	University of Wisconsin.	28,139	.8
Contratto (1943)	Harvard freshmen.[2]	2,856	.3
Shearer et al. (1952).	University of Colorado.	3,645	.7
Goggio (1952)	University of California.	11,096	.3

[1] Modified from Shearer et al. (*7*).
[2] Males.

Table 4. Frequency of rheumatic fever recurrences following proved group A streptococcal infections

Treatment status	Number of streptococcal infections	Recurrences of rheumatic fever	
		Number	Percent
Not treated with penicillin	11	6	54
Treated with oral penicillin	25	2	8

SOURCE: Reference 12.

tions of the Committee on Prevention of Rheumatic Fever and Bacterial Endocarditis of the Council on Rheumatic Fever and Congenital Heart Disease (*14*). The committee recommends that children who have had rheumatic fever be maintained on a regimen of continuous prophylaxis indefinitely.

We know that continuous prophylaxis can reduce the rheumatic fever recurrence rate by well over 85 percent if conscientiously carried out (*15*, *16*). Experience reveals that either oral sulfadiazine, oral penicillin, or benzathine penicillin administered intramuscularly can be effective (table 5). However, there have been more frequent breakthroughs of streptococcal infections on sulfadiazine and on oral penicillin than with intramuscular benzathine penicillin (*17*). An increase in the dosage of oral penicillin of 200,000 or 250,000 units twice a day is now being recommended by the Committee on

Table 5. Effect of prophylaxis on recurrences of rheumatic fever

Prophylaxis status	Type of prophylaxis					
	Sulfonamide			Oral penicillin		
	Patient-years	Rheumatic attacks		Patient-years	Rheumatic attacks	
		Number	Percent		Number	Percent
Control	1,697	238	14.0	932	81	8.7
Prophylaxis	1,358	27	1.9	740	5	.6

SOURCE: Modified from Stollerman (*16*).

Prevention of Rheumatic Fever and Bacterial Endocarditis in its revised prevention statement (*14*). These basic recommendations are sound and can be used in planning community rheumatic fever prevention programs.

Most States have some type of rheumatic fever program. Some of these have been in operation for many years. Since 1939, a great deal has been accomplished through the support of State rheumatic fever programs by the Children's Bureau, but there is still much to be done. We have not fully persuaded physicians, parents, and patients on the importance of preventing rheumatic fever recurrences. For example, the survey of college students that is now being carried on by the Heart Disease Control Program in cooperation with the American College Health Association is revealing a glaring lack of prophylaxis in the known cases of rheumatic heart disease either following the initial attack or at the present time. In these preliminary data, only 73 out of 659 college students with a known history of rheumatic fever are on any kind of prophylaxis. We certainly cannot say we have succeeded in getting across the message of continuing prevention of recurrent attacks of rheumatic fever when only 11 percent of these known cases are following any type of prophylactic regimen.

A recent report from Herrick House (*18*) emphasizes this discouraging state of affairs.

A 1955 annual followup of 100 children discharged after participating in a program of accelerated rehabilitation following an acute attack of rheumatic fever showed that 1 year later 29 of the 100 were receiving no medical care. Of the 71 under medical care, 38 were getting no prophylactic medication. Thus, 67 of the 100 were receiving no prophylaxis for rheumatic fever recurrences.

Making penicillin available to physicians for treating patients with a history of rheumatic fever is not always a solution. The physician committee of one heart association voted to provide oral or benzathine penicillin to physicians who had rheumatic children under their care. Approximately 90 such cases were reported as known to the practicing physicians in that community. One year later a review of the program revealed that only about six

children out of this group could be said to have followed a satisfactory preventive regimen.

Essential Program Features

What are some of the essential features in a successful rheumatic fever prevention program? Perhaps most important is the sincere interest of physicians and community agencies in setting up an effective mechanism for maintaining a long-term prophylaxis program.

The problem of rheumatic fever prevention cannot be solved by physicians alone, by the patients alone, by the health department alone, or by the heart association alone. This is a problem that requires community interest and cooperation. Planning such a program should be done with the cooperation of all the interested groups concerned. No blanket program will meet the needs of every community, but rather each community's individual needs, and its resources available to meet these needs, must be visualized in planning a program (see inset below).

Basic to any program plan is the continuing interest and support of the practicing physicians, parents, school nurses and teachers, public health nurses, and social workers. Each of these must believe in the value of what is being done and the importance of following the long-term regimen. If the physicians are not convinced, certainly it is hard to expect that

IMPORTANT PROGRAM ELEMENTS

cooperative planning by interested community groups	★ Practicing physicians ★ Health department ★ Heart association
educational program enlisting cooperation of	★ Physicians and clinics ★ Parents ★ School system ★ Public health nurse
diagnostic services for problem cases	★ Cardiological consultation ★ Laboratory services
up-to-date register maintained by health department	★ Focal point and responsible agency for long-term followup
prophylactic penicillin	★ Low cost for nonindigent patients ★ Free for indigent patients
effective followup plus services	★ Prevent lapses from medical supervision ★ Prevent lapses in prophylaxis ★ Provide nursing services, home teaching, social services, other services as needed

parents and children will be convinced of the importance of prevention.

The Case Register

An important device for developing an effective program is the case register. Case registers have been used successfully for many years in tuberculosis and other health programs requiring long-term followup. The case register provides a central mechanism which shows whether or not the rheumatic patient stays under medical supervision and receives prophylaxis regularly. Several cities have developed effective case registers and followup services. New York City, San Francisco, and Chicago are examples of such programs in larger cities. Pueblo, Colo., is an example of a program in a small city-county area. Fixing responsibility in one agency for the coordination of the program is important to the long-term success of the program.

Providing penicillin at a reasonable cost, or free when needed, is an important aspect of the prevention program. Patients enrolled on the register qualify for this penicillin, and it is made available on presentation of a prescription from the attending physician.

When the medical appointment is not kept or the prescription is not filled by a given date, followup begins. Clerks, public health nurses, or the medical social worker may be called on to look into the reason for lapses from care, depending on the nature of the problem involved.

Within a well-developed program of rheumatic fever prevention there will be a mechanism for adding new cases to the register as they are detected in school health programs or through other means. Private and public facilities for the evaluation of diagnoses are also needed, for it is as important to avoid imposing an unnecessary prophylactic regimen on a child with a functional murmur as it is to keep the child with true rheumatic fever on prophylaxis.

A label of heart disease not only may cause adverse psychological problems but may also create later difficulties in obtaining employment, or it may increase costs of personal insurance.

Availability to physicians of accurate and convenient laboratory services for processing throat cultures of patients with suspected streptococcal disease is a fundamental part of an effective rheumatic fever prevention program. Streptococcal antibody tests such as the antistreptolysin O titer should also be available through some central laboratory to help clarify the diagnosis when rheumatic fever is suspected (*19*).

The focus of attention on the problem of preventing rheumatic fever recurrences is in itself important, but the other problems that require attention should not be overlooked. The family, school, and vocational problems can be met more readily by community services if the framework of a rheumatic fever prevention program exists.

Summary

Although basic research into the etiology and pathogenesis of rheumatic fever is still urgently needed, one of the greatest practical problems in rheumatic fever prevention is a lack of effective application of available preventive measures.

Every State in the United States reported deaths from rheumatic fever and rheumatic heart disease in 1955. Progress in the control of rheumatic fever through the prevention or prompt treatment of streptococcal infections has resulted in the impression that this disease is now of minor importance. This is not true.

Current experience reveals that individual efforts of physicians or patients are not enough to maintain interest in and adherence to prescribed preventive measures. Approximately an 85-percent reduction in recurrences of rheumatic fever could be expected if current recommendations on prophylaxis of rheumatic fever were followed conscientiously.

Health departments, heart associations, and practicing physicians need to join forces in developing effective community rheumatic fever prevention programs that will assure the application of proved measures for the prevention of rheumatic fever.

REFERENCES

(*1*) Fleming, D. S., Hirschboeck, F. J., and Cosgriff, J. A.: Minnesota rheumatic fever survey, 1955. Minnesota Med. 39: 208–213, April 1956.

(2) U. S. Public Health Service: Cardiovascular disease. PHS Pub. No. 429. Washington, D. C., U. S. Government Printing Office, 1956, table 18, p. 33.

(3) Mattison, B. F., Lambert, E. C., and Mosher, W. E.: Cardiac screening in a school health program. New York State J. Med. 53: 2966–2970, Dec. 15, 1953.

(4) Maresh, G. J., Dodge, H. J., and Lichty, J. A.: Incidence of heart disease among Colorado school children. J. A. M. A. 149: 802–805, June 28, 1952.

(5) U. S. Public Health Service: Cardiovascular disease. PHS Pub. No. 429. Washington, D. C., U. S. Government Printing Office, 1956, table 19, p. 34.

(6) Stokes, J., III, and Dawber, T. R.: Rheumatic heart disease in the Framingham study. New England J. Med. 255: 1228–1233, Dec. 27, 1956.

(7) Shearer, M. C., Sikkema, S. H., and Holden, L. W.: Prevalence of heart disease in university students. Am. J. Pub. Health 42: 1103–1110, September 1952.

(8) Coburn, A. F., and Young, D. C.: The epidemiology of hemolytic streptococcus. Baltimore, Williams and Wilkins Co., 1949, 170 pp.

(9) Rheumatic fever—A symposium. Edited by L. Thomas. Minneapolis, University of Minnesota press, 1952, 349 pp.

(10) Recommendations of the State and Territorial health officers. 6. Community prophylaxis of streptococcal infections. *In* Proceedings, 1956 annual conference. PHS Pub. No. 522. Washington, D. C., U. S. Government Printing Office, 1957, p. 41.

(11) Poskanzer, D. C., Feldman, H. A., Beadenkopf, W. G., Kuroda, K., Drislane, A., and Diamond, E. L.: Epidemiology of civilian streptococcal outbreaks before and after penicillin prophylaxis. Am. J. Pub. Health 46: 1513–1524, December 1956.

(12) Massell, B. F., Sturgis, G. P., Knobloch, J. D., Streeper, R. B., Hall, T. N., and Norcross, P.: Prevention of rheumatic fever by prompt penicillin therapy of hemolytic streptococcic respiratory infections. J. A. M. A. 146: 1469–1474, Aug. 18, 1951.

(13) Bland, E. F., and Jones, T. D.: Rheumatic fever and rheumatic heart disease: A twenty-year report on 1,000 patients followed since childhood. Circulation 4: 836–843, December 1951.

(14) American Heart Association: Prevention of rheumatic fever and bacterial endocarditis through control of streptococcal infections. Circulation 15: 154–158, January 1957.

(15) Rammelkamp, C. H., Jr., Houser, H. B., Hahn, E. O., Wannamaker, L. W., Denny, F. W., and Eckhardt, G. C.: The prevention of rheumatic fever. *In* Rheumatic fever—A symposium, edited by L. Thomas. Minneapolis, University of Minnesota Press, 1952, pp. 304–315.

(16) Stollerman, G. H.: The use of antibiotics for the prevention of rheumatic fever. Am. J. Med. 17: 757–767, December 1954.

(17) Wood, H. F., Stollerman, G. H., Rusoff, J. H., Taranta, A., Haas, R. H., and Feinstein, A. R.: Controlled study of three methods of prophylaxis against streptococcal infection in a population of rheumatic children. I. Streptococcal infections and recurrences of acute rheumatic fever in the first two years of the study. Abstract. Proceedings of the 29th Scientific Sessions of the American Heart Association, October 26–29, 1956, Cincinnati, Ohio. p. 126.

(18) Lendrum, B. L., and Kobrin, C.: Prevention of recurrent attacks of rheumatic fever: Problems revealed by long-term follow-up. J. A. M. A. 162: 13–16, Sept. 1, 1956.

(19) Berliner, R W., and Stewart, W. H.: The public health laboratory in the community control of heart diseases. Am. J. Pub. Health 47: 719–724, June 1957.

Violations of Interstate Quarantine Regulations

In the first conviction on violations of the interstate quarantine regulations, five hog feeders were recently found guilty by the United States District Court of Camden, N. J., of interstate transportation and feeding of uncooked garbage to hogs. The regulations under which they were convicted require that all garbage carried in interstate traffic and fed to swine must be cooked or heat treated to destroy agents of trichinosis.

The convicted hog feeders were placed on probation for 2 years under Public Health Service supervision, and warnings were issued that like violations will be prosecuted.

Swimming Pool Injuries, Mycobacteria, and Tuberculosis-Like Disease

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ABRASIVE accidents in swimming pools are not rare. They may occur in diving, in getting in or out of the pool, or in underwater swimming. Most frequently such accidents involve the bridge of the nose, the elbows, or the knees. Although in themselves they are seldom of consequence, it has recently been recognized that this type of accident may lead to inoculation lupus vulgaris, granulomatous tuberculosis lesions, or other tuberculosis-like lesions.

Mycobacterium tuberculosis

Hellerström (*1*), in 1951, reviewed six cases of inoculation lupus vulgaris, some of which he had reported as early as 1939 (*2*). They were all associated with swimming-pool injuries. Describing the clinical features, which were strikingly uniform, he wrote:

> Within an area of a couple of square centimeters or more on the bridge of the nose an eruption developed, which consisted of soft papules, reddish-violet to reddish-brown in color, and ranging in size from a pinhead to a split pea; some of the papules were topped by crusts and coalesced. Two of the cases presented elevated ulcers measuring 15 by 15 and 7 by 7 millimeters, respectively. In the major proportion of cases the initial abrasion had healed when the papules appeared in the vicinity. On diascopic examination the papules showed the distinctive color of lupus nodules, and they were easily penetrated by a blunt probe applied with slight pressure. Hence, the clinical diagnosis was lupus vulgaris. The regional lymph nodes were either not at all, or only slightly to moderately, enlarged.

In one case Hellerström observed acid-fast bacilli in the lesions, thus affording some laboratory confirmation to his diagnosis.

Later Hellerström (*3*), using more sensitive laboratory techniques, was able to isolate the tubercle bacillus from one swimming pool. He felt that the problem of skin tuberculosis acquired in swimming pools was complex and far from being solved. He suggested that, although tuberculosis control officers and sanitary engineers have an interest, "tuberculosis as a waterborne infection is a problem that calls for the attention of dermatologists . . ."

Also in 1951, Cleveland (*4*) reported four cases from Canada. He concluded that "the clinical and histopathologic appearance of the lesions was strongly suggestive of tuberculosis cutis" although "no acid-fast bacilli were demonstrated in the lesions . . ." All Cleveland's cases were associated with the same swimming pool, which was filled with tidal sea water and was under good sanitary control. He believed that the pool contamination might have resulted from the discharge of urine or sputum from an infected person. In summary, Cleveland suggested that "tuberculous infection may occur more often than the absence of reported cases would indicate."

In commenting on these papers, Sulzberger and Baer (*5a*) suggested that the etiology was questionable. They pointed out that the smegma bacillus may be present in pools in large numbers and also that this organism when inoculated into the skin produced a "tuberculoid type of response."

Mycobacterium balnei

In a comprehensive monograph, Linell and Nordén (*6*) summarized previous studies and described an epidemic of 80 cases of benign skin ulceration in Örebro, Sweden. They isolated a previously unknown *Mycobacterium* very similar to Koch's bacillus and gave it the specific name *balnei*.

Linell and Nordén's cases were characterized by a papular lesion of spongy consistency which was typically located on the outside of the elbow. The lesion grew slowly and eventually crusted, with scaling of the surrounding skin. Thick secretion developed under the crust and healing proceeded slowly, leaving a bluish-red

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soft scar. The whole sequence could last 2 years, especially if complicated by purulent infection. Histologically most of the lesions were granulomatous, and acid-fast bacilli were demonstrated in only one case. However, the organism was isolated from both the water and the walls of the swimming pool associated with the epidemic, and laboratory studies on animals and human volunteers (the authors) proved conclusively that *M. balnei* was the etiological agent. No new cases occurred after the pool was rebuilt, replacing the rough concrete walls with smooth tiles, and the chlorination system made more effective.

Zettergren, cited by Linell and Nordén (*6*), reported a similar episode of 60 cases in Västerås, Sweden. Although *Mycobacterium marinum* was considered the etiological agent by Zettergren, Linell and Nordén isolated *M. balnei* from lesions and from the pool. The term "mycobacteriosis balnearea" was applied to the syndrome. When breakpoint chlorination was introduced, the epidemic was brought completely under control.

Other Reported Cases

Brück (*7*), in 1951, described 3 cases of inoculation tuberculosis, 2 of which were associated with swimming pool injuries. In 1952, he reported another case of inoculation lupus (*8*). Isolation of the tubercle bacillus from the lesions completely confirmed the clinical diagnosis. These findings led Brück to conclude that "so-called swimmer's lupus," or mycobacteriosis balnearea, could be separated into two types: (*a*) cases in which *M. tuberculosis* was the causative agent, and (*b*) cases in which *M. balnei* was responsible for the infection. He placed his 1952 case and those of Hellerström in the first category, and the cases of Linell and Nordén and Zettergren in the second. Hellerström, in a paper already cited (*3*), reviewed all of the available case histories and concluded with Brück that similar clinical manifestations may have been due to different etiological agents. He suggested, however, that the organism isolated by Linell and Nordén might be a mutant of *M. tuberculosis*, or that it might be *M. marinum* as believed by Zettergren. He was unwilling to accept *M. balnei* as the responsible agent.

Tolmach and Frank (*9*), in the United States, reported another case of inoculation lupus vulgaris, which was characterized as skin granuloma with tubercle formation of unknown etiology. This infection resulted from a nose abrasion in a swimming-pool accident.

Nine cases of post-swimming-pool abrasion infections diagnosed as tuberculosis verrucosa cutis were observed by Rees and Bennett (*10*) in San Francisco. The clinical picture was quite different from that given by Hellerström. As to the etiology, Rees and Bennett ruled out granuloma due to silicates and deep fungus infections, but they were unable positively to define the agent. They mentioned the possibility of infection by the smegma bacillus or by *M. tuberculosis*, although neither was demonstrated in the lesions or the pool.

In the 1954–1955 Year Book of Dermatology and Syphilology (*5b*), Sulzberger and Baer reviewed the monograph by Linell and Nordén and commented as follows: "This is a masterly clarification of a relatively new entity apparently caused by a quite newly discovered acid-fast mycobacterium [*M. balnei*]. It appears virtually certain that this is the entity previously described by Hellerström in Sweden, D. E. H. Cleveland in Canada, Rees and Bennett and Jesse Tolmach and S. B. Frank . . . in the United States. It is small wonder that this infection of the bridge of the nose and other sites was in the past often considered a type of tuberculosis, and it is likely that the uninitiated will continue in this error in many future cases."

Conclusion

It is clear from the foregoing review that a new disease entity—a lupuslike dermatitis—and possibly a new means of transmitting skin tuberculosis are now known. What is not known is how widespread or frequent the infections are. The finding of cases in Europe, Canada, and the United States would indicate widespread geographic distribution. Those concerned with the operation of swimming pools should be aware of the potential hazard from this source, and the clinician should consider swimming-pool trauma in the diagnosis of tuberculosis-like skin infections.

From the limited data available, it would

appear that swimming-pool construction and sanitation may play a significant role in controlling the spread of this disease entity. Smooth-surface walls and breakpoint chlorination have proved effective in curtailing epidemics.

REFERENCES

(1) Hellerström, S.: Collected cases of inoculation lupus vulgaris. Acta dermat. venereol. 31: 194–209 (1951).

(2) Hellerström, S.: Contribution à la connaissance de l'infection tuberculeuse primaire de la peau et de la muqueuse. Acta dermat. venereol. 20: 276–301 (1939).

(3) Hellerström, S.: Water-borne tuberculosis and similar infections of the skin in swimming pools. Acta dermat. venereol. 32: 449–461 (1952).

(4) Cleveland, D. E. H.: Possible tuberculosis skin infection from a swimming pool. Acta dermat. venereol. 31: 147–152 (1951).

(5) Sulzberger, M. B., and Baer, R. L., Eds.: Year book of dermatology and syphilology. (*a*) 1951; (*b*) 1954–1955. Chicago, Year Book Publishers, 1952, 1955.

(6) Linell, F., and Nordén, Å.: *Mycobacterium balnei*, a new acid-fast bacillus occurring in swimming pools and capable of producing skin lesions in humans. Acta tuberc. Scand. Supplement 33: 1–84 (1954).

(7) Brück, C.: Three cases of inoculation tuberculosis. Acta dermat. venereol. 31: 212–216 (1951).

(8) Brück, C.: Is there a possibility of tuberculous infection through injuries sustained in swimming pools? Acta dermat. venereol. 32: 443–448 (1952).

(9) Tolmach, J. A., and Frank, S. B.: Granuloma of skin with tubercle formation following swimming pool injury. J. A. M. A. 151: 724–726 (1953).

(10) Rees, R. B., and Bennett, J. H.: Granuloma following swimming pool abrasion. J. A. M. A. 152: 1606–1610 (1953).

Air Pollution Training Courses

Six courses in air pollution will be conducted by the Air Pollution Training Section, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, during fiscal year 1958. They are designed for engineers, chemists, and other scientists in State and local health departments, control agencies, and university and industrial groups. Enrollment is by application.

The courses will be given according to the following schedule:

November 12–22, 1957	Atmospheric sampling
January 13–24, 1958	Atmospheric sampling analysis
February 17–21, 1958	Detection and control of radioactive pollutants in air
March 10–12, 1958	Air pollution effects on vegetation
April 7–11, 1958	Source sampling and analysis
April 14–18, 1958	Control of air pollution sources

Applications and further information can be obtained by writing Paul F. Woolrich, chief, Air Pollution Training, Robert A. Taft Sanitary Engineering Center, Public Health Service, 4676 Columbia Parkway, Cincinnati, Ohio.

Mid-Century Inventory

University Hospital's Diamond Jubilee

Health and peace, the hope of mankind, was the theme of the diamond jubilee convocation of University Hospital, a unit of New York University-Bellevue Medical Center, observed March 4 and 5, 1957. The 2-day program included discussions by Dr. Abraham Flexner, Dr. Howard Rusk, Hon. John E. Fogarty, Dr. Chester S. Keefer, Dr. Cassius J. Van Slyke, Dr. Herman E. Hilleboe, Dr. Edwin L. Crosby, and other distinguished guests. Selections from the program appear below. William E. Robinson was chairman of the convocation and Charles S. McVeigh, chairman of the steering committee. A message to the convocation from President Eisenhower was conveyed by Maj. Gen. Howard McC. Snyder.

The program was devoted to four general topics: chronic diseases, mortal enemies of man (cancer, viruses, bacteria), medical research at the crossroads, and major approaches to health.

Virus Diseases

brief

Viruses cause no fewer than 50 different diseases in man and many more than that in plants and in animals. In human beings they lead to an enormous burden of illness, although in general, except in huge pandemics of the kind that occurred in 1918, most virus diseases do not directly cause death.

In this country they tend to produce between 4 and 6 episodes of illness per person per year. On the average, in the United States, man is afflicted by one or another virus disease about 10 percent of his life. Over a span of 70 years, man suffers for 7 years with virus diseases. To put it another way, in this country, about 5 billion man-days are lost each year through virus diseases. No other category of disease approaches this total in terms of human disability.

The highest incidence results from those diseases we think least of and accept as inevitable ailments. These are the diseases of childhood, such as measles, chickenpox, and mumps, and the numerous respiratory infections, colds, influenza, and various forms of pneumonia, which occur throughout life.

The severity of these processes ranges from exceedingly mild, as in the afebrile common cold, through severe, as in paralytic poliomyelitis, to fatal, as in rabies.

The duration of virus diseases ranges from a few days or a week or two, as with the childhood and respiratory infections, to months,

Based on a paper by Dr. Frank L. Horsfall, Jr., vice president and physician in chief, Rockefeller Institute for Medical Research, New York City.

sometimes many months, as in the case of infectious hepatitis or infectious mononucleosis.

Prevention and Treatment

Although there are some 50 virus diseases of man, it is possible now to provide effective prevention against only a handful, 5 or 6 at most, and it is possible to provide specific and effective treatment for none. Once started, virus diseases run their natural course unaffected by the best efforts of modern medicine.

The biology of virus infection offers an explanation for the difficulties that have been encountered in efforts to control them. Viruses are the smallest of all infectious agents, so small that they usually cannot be seen without an electron microscope. They multiply in a unique way and do so only inside living susceptible cells. When outside such cells, they have no metabolism of their own and so are inaccessible to the direct influence of antimetabolites and antimicrobial substances.

The most important basic principle that has been developed in the field of virus diseases is this: Without virus multiplication there is no virus disease. This places the mechanism of multiplication at the very heart of the problem. If we knew more of this mechanism perhaps means could be developed to control virus diseases.

The effective procedures for the prevention of a few virus diseases are almost all immunological in nature. Smallpox and yellow fever can be prevented effectively by modified but active virus vaccines.

Rabies, influenza, and poliomyelitis can be prevented by inactivated virus vaccines. In the future there may be vaccines available for measles, mumps, for certain of the respiratory infections, and possibly for some of the virus diseases that attack the brain.

Temporary protection can be secured against measles and hepatitis by the use of gamma globulin, derived from the blood of human beings, but most virus diseases, and most importantly, the commonest, cannot yet be effectively prevented.

Although there has been an intensive search for effective chemotherapeutic agents useful in the treatment of virus diseases for more than 20 years, modern antimicrobial substances, including antibiotics, have been of no avail.

Virus diseases remain the largest unsolved problem among infectious processes. They may have important implications bearing on other large problems in medicine, even on the problem of cancer.

The objective in treatment is to prevent multiplication of the virus without damaging the host. Some encouraging results have been secured in experimental laboratories recently. Among the striking advances have been those made by my associates at the Rockefeller Institute. New synthetic chemical compounds have been developed and some are highly active against various viruses in experimental animals.

They have been shown to inhibit the multiplication of influenza, mumps, and poliomyelitis viruses in the laboratory. The most potent are as active as the best antimicrobial compounds, but they act in a different way. They prevent the production of a substance called nucleic acid, an essential component of viruses, and do not markedly or permanently damage the host cell. In other laboratories, other approaches are being pursued with rewarding results.

It can be expected that the combined and continuing efforts of organic chemists, biochemists, and biologists, will solve these problems eventually. We begin to look forward without unfounded optimism to the time when common virus diseases will be preventable, treatable, and even curable.

Bacteria

brief

Bacteria can play the role of man's best friend. Many of the chemical processes by which our soil is enriched, fermentative processes initiated, and wastes disposed of are dependent upon beneficent bacteria, and indeed, antibiotics themselves are bacterial products. In addition, there are a host of bacteria that seemingly have

Based on a paper by Dr. Thomas B. Turner, director of the department of microbiology, Johns Hopkins University School of Hygiene and Public Health, Baltimore, Md.

no impact on the life of man. But about 100 years ago, certain groups of bacteria began to be identified with serious human disease.

Today, what does man have to fear from bacteria and bacterial diseases? What may we hope to accomplish by the continued study of this great segment of microscopic life? We have mainly to fear complacency about the bacterial diseases and ignorance which so often masquerades as knowledge.

It is commonplace to hear that infectious diseases are no longer important, and in one sense this is true. But with the suppression of bacterial killers new problems emerge.

We are approaching that pristine state of the germ-free animals in the laboratories of Notre Dame, animals that rapidly succumb to such bacteria as the colon bacillus, which is normally present and harmless in every free-living animal.

Not only are germ-free animals entirely nonresistant to these normally harmless bacteria, but the capacity of their immune mechanisms to respond is greatly impaired.

It has been said by eminent sanitary engineers that, if the water supplies of our cities were disrupted, perhaps by war, for a period of several weeks, the population would be decimated by intestinal diseases.

It should be recalled that a large segment of the deaths following excessive exposure to radiation injury are due to bacterial invasion through the damaged lining of the intestines.

But let us turn to a peaceful, civilized society where most every want of man can be satisfied, where the bacterial diseases have been smothered under a blanket of antibiotics. What has happened that makes us uneasy, and increasingly aware of problems ahead? An understanding of these problems calls for scientific knowledge in bacterial ecology, bacterial genetics, and immunology.

I sketch here only the bare outlines. To take ecology first: every portion of the body that communicates with the outside environment has, from a few days after birth, a mixed bacterial population. The skin, the mouth, the nose and throat, the intestinal tract, each contains many kinds of bacteria—the normal flora of each particular area has been well known for many years.

Just why certain kinds of bacteria were present in large numbers and others in small numbers was not known, and, indeed, it is probable that no one gave the question much thought. Obviously, these bacteria had not only reached an accommodation with the human being who served as their host, but they had reached an accommodation with each other, much as rabbits and foxes on an island achieve a balance, which, although it may fluctuate a little, remains fairly stable until some extraneous influence enters the picture.

And so it was with the normal bacterial populations. Under the influence of antibiotic treatment, certain of these bacteria were greatly reduced in numbers, and then, to our surprise, other kinds of bacteria formerly present only in small numbers multiplied and produced diseases.

As for bacterial genetics, the staphylococcus, for example, is a ubiquitous species. Formerly, it was responsible for an occasional boil or for the infection of a wound or minor injury. It was discovered early that these bacteria in general are easily destroyed by penicillin.

But then it was found that a very small proportion of these organisms, in the order of 1 in 100,000,000, were resistant to penicillin owing to genetic factors. Before long, in more and more patients admitted to hospitals, all the staphylococci they harbored were resistant to penicillin and frequently to other antibiotics. Staphylococcus infections have now emerged as one of the most common and serious of the bacterial infections. Their treatment taxes to the utmost the ingenuity of the physician.

During the past 10 years, the penicillin-sensitive staphylococci have been killed off, leaving the penicillin-resistant strains to multiply and colonize. This same phenomenon might be taking place with certain other bacteria.

The entrance of bacteria or other infectious agents into the body starts a train of events which we refer to under the heading of immunity. A series of defense mechanisms is invoked, among which is the production of antibodies. These antibodies not only have some capacity of inhibiting or destroying the invading bacteria, but they also tend to persist, thus guarding the body against subsequent invasion by the same or closely related bacteria. This

defense, however, is maintained at a price, for whenever these or closely related bacteria gain access to the body, a reaction between this antigen, as we call it, and the antibody takes place. Very often this interaction occurs on the surface or within certain cells of the body, and in this process the cells may be damaged.

The point is that antibiotics, products of bacteria, have the capacity to invoke these damaging reactions in the body cells. As the use of antibiotics broadens, the observed number of these reactions increases. My discussion already has suggested by implication certain fruitful lines of investigation. There are also areas in which research gives promise, because of the essential unity of biology, of contributing to areas which superficially at least might be regarded as remote from the problems of bacteria.

Because oft-repeated antigen-antibody reactions, perhaps quite minor in themselves, can lead to impressive degrees of damage, especially to connective tissue cells, there has been a good deal of informed speculation that the alarming increase in the so-called collagen diseases, such as lupus erythematosus, rheumatoid arthritis, and certain abnormalities of the medium-sized arteries of the human body, might be due in essence to this phenomenon. It may be that the common cold, measles, whooping cough, and as yet unaccountable virus infections are the genesis of many distressing ills of later life. If so, one approach to the prevention of the chronic diseases is clear.

The study of the bacterial cell has contributed much to our knowledge of cell physiology in general, and scientists are by no means at the end of this string. Many metabolic pathways have yet to be mapped out, and drugs and chemicals tested for their capacity to block certain essential metabolic functions.

There is always the possibility, too, that a mutant bacterial cell may partake of some of the unique properties of cancer cells and thus provide copious supplies of readily available test materials.

The study of bacterial physiology has made enormous contributions to our understanding of the role of vitamins in nutrition, to genetics, and to radiobiology, and such studies may well continue to yield important new knowledge in these areas. Studies in dental health may take a cue from the fact that germ-free animals do not develop tooth decay regardless of the diet they are fed.

The effect of nonspecific factors that influence man's reaction to harmful bacteria is just beginning to be understood. Such factors as environmental temperatures, diet, and hormones seemingly have the capacity substantially to modify the host's reaction to bacterial infection, and there are indications that virus infections, and even malignancies, probably respond to some of these same basic biological laws.

Bacterial diseases do not clamor for attention. They no longer kill like wanton murderers. But dare we rest in the happy thought that man is now safe from this quarter at least?

Immunology

brief

The fields in which specific and precise techniques of immunology have been successfully employed cover a broad area in biology. They range from such apparently crude matters as the mechanisms involved in the defense of the body against intrusion by foreign invaders to the pure techniques of immunochemistry, in which antibodies are used as a sort of chemical reagent for the quantitative measurement of substances which cannot even be detected, much less measured, by ordinary chemical means.

Indeed, in the capacity to measure things in exact quantitative terms, immunology is one of the few branches of biochemistry to approach the physical sciences.

Immunology is, in part, the study of antibodies produced by the cells of the host and released into the blood in response to stimulation by foreign agents. Much has been learned about this process and many practical applications of inestimable value to medicine have been made. It is known that antibodies are gamma globulins, proteins manufactured by specialized

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Based on a paper by Dr. Lewis Thomas, professor and chairman of the department of pathology, New York University-Bellevue Medical Center, New York City.

cells called "plasma cells." When these cells are deficient in number, the result is agammaglobulinemia, in which the patient is rapidly overwhelmed by bacterial infection unless treated by injections of gamma globulin extracted from normal human serum.

One curious and useful fact is that, once the body has been exposed to a particular antigen and has learned to manufacture a particular antibody, it retains a memory of the experience so that when it is exposed again to the same antigen, even years later, it is able to produce abundant amounts of the antibody with great speed.

This accelerated reaction to previously encountered antigens, sometimes known as the "booster" response, is an important mechanism in immunity. Indeed, it is likely that immunity to most bacterial infections is not so much due to the actual possession of antibody ready made or ready at hand in the blood when the bacteria make their appearance as it is to the host's capacity to recognize them, to remember what to do, and to make antibody in a hurry.

Factors involved in this faculty of remembering a particular antigen are not at all clear. The problem has recently engaged the attentive interest of the enzyme chemists, who have run into an analogous situation in their own field. Cells which produce particular enzymes in response to chemical stimulation also display a kind of memory of this act, and they will do so much more readily on a second occasion.

And now, one of the really elegant processions to be seen in science—the crossing and recrossing of two interdisciplinary lines by meditative investigators—is going on between the adjacent fields of immunology and enzymology.

Since the turn of the century we have seen the development of vaccines for the prevention of some of the nastiest diseases of mankind: diphtheria, tetanus, yellow fever, typhoid, typhus, rabies, encephalitis, and now poliomyelitis.

Antiserums have been developed for the treatment of diphtheria, tetanus, and the bacterial pneumonias; serologic tests for the clinical diagnosis of a whole host of diseases, from the Wassermann test for syphilis to the measurement of antistreptococcus antibodies in rheumatic fever and Bright's disease. Immunochemical research, which had its beginnings in Avery's delineation of bacterial polysaccharides by means of specific antibody, has led recently to the most delicate methods for separating and characterizing the proteins of the blood and learning what they are, where they come from, and what they do—this has the sound of a mature, highly developed science.

Does immunology have a future that can match its past? In my own view, we have seen only the beginning.

Among the problems which lie before us are, first, the great group of unsolved diseases of hypersensitivity, and, second, the transplantation of tissues.

Hypersensitivity

That disturbances of the immune mechanism may be the basis for human disease has been suspected for many years. We have substantial proof that abnormal antibodies are in part the cause of certain diseases. In some of the acute hemolytic anemias, massive destruction of red blood corpuscles occurs as a result of the production, by the patient himself, of antibodies which react with his own red cells. Similarly, in some cases of hemorrhagic disease, the blood platelets are acted upon by an antibody which destroys them and thus interferes with the coagulation of the blood.

The collagen diseases, or diseases of connective tissue, including rheumatic fever, rheumatoid arthritis, periarteritis nodosa, and disseminated lupus erythematosus resemble each other in important pathological respects. They are suspected of being based on the abnormal functioning of the body's immune mechanisms.

In rheumatic fever, for example, there is a strong likelihood that the hemolytic streptococcus infection, which always occurs about 2 weeks before onset, brings about a generalized allergic reaction in which the heart and joints are peculiarly involved.

This kind of allergy, in which bacteria or their products seem to furnish the responsible antigens, is one of the great mysteries in immunology. Its simplest form is in the tuberculin reaction, and it probably is important in the symptoms and lesions of tuberculosis itself

as well as in other diseases, including typhoid fever, brucellosis, and perhaps even in pneumonia.

We know almost nothing about the mechanisms of bacterial hypersensitivity. Rather than being caused by a circulating antibody of the conventional sort, it is apparently mediated by the leucocytes, which behave as though they contain antibody.

The bacterial type of hypersensitivity may stem from an enormous blunder on the part of the body's defense mechanism. It has been shown experimentally that this type of hypersensitivity can lead to degenerative change in blood vessels and to the destruction, by the host, of large areas of his own tissues.

Transplantation Reactions

Another reason for investigating the process is the reaction of the body to transplanted tissues and organs. If a human being receives a graft of his own skin the grafted skin receives a new supply of blood vessels within 2 or 3 days and is well healed in about 7 or 8 days.

If the graft is a homograft, that is, taken from another human being, precisely the same events occur. But on the seventh or eighth day, small hemorrhages occur throughout the graft, the blood supply is cut off, and the tissue is completely destroyed within the next 2 or 3 days. By the 10th day, it is gone. If a new area of skin is taken from the same donor and grafted on the same recipient, the process of rejection is accelerated. The graft is rejected on the third or fourth day instead of on the seventh or eighth.

Rejection of a tissue homograft is a kind of hypersensitivity closely related to bacterial hypersensitivity. It is as though the host at first fails to recognize it as a foreign tissue and provides it with his own blood vessels and allows it to heal before the immune reaction sets in on the seventh day.

After having been grafted twice with the skin of another, the host will thereafter reject only that person's skin in an accelerated fashion; grafts from all others will not be rejected until the seventh or eighth day. This kind of immunity or hypersensitivity indicates that the antigenic components in our tissues identify each of us as do our fingerprints. For surgery particularly this problem has extremely practical implications.

Not only skin but kidney, liver, lung, thyroid, adrenal, and other tissues can be transplanted, and all will survive until the host's immune mechanisms come into operation destroying the tissues. The only circumstances in which grafted organs will survive permanently are those involving identical twins, each possessing the same tissue antigens as the other, and avascular tissues, such as the cornea, which does not require a blood supply of its own.

A beam of sharp light has been thrown on the problem of reconstructive surgery by a group of British investigators. Led by Medawar and Billingham, they have succeeded in inducing complete tolerance to homografts in mice by exposing recipient mice during fetal development, or in the first day of life, to tissue cells from the projective donor animals. When these mice become adults, they can be grafted successfully with skin and other tissue homografts. Similar experiments have been successful in chickens, rats, and other laboratory animals.

Medawar's laboratory has produced a lively kind of zoo, with black mice bearing permanent grafts of white mice, and white chickens bearing grafts from which grow red feathers. Although this certainly does not immediately solve the problem of repairing or replacing damaged or destroyed human tissues, it should give us pause, and, I think, cause for hope in the future.

Chronic Diseases

brief

I was delighted beyond expression to hear the great sage of medicine, Dr. Flexner, say that his mission in 1907 was to set up a program to rehabilitate the medical schools. To have him use that word in the concept that he did was

Based on a paper by Dr. Howard A. Rusk, professor and chairman of the department of physical medicine and rehabilitation, New York University-Bellevue Medical Center, New York City.

most heartening to me. Roughly, it ties in with the definition of rehabilitation as we know it, which is simply this—a program to assist the disabled to live the best lives possible. His mission was to aid crippled medical schools to teach the best medicine possible.

It is fundamental in the entire concept of medical teaching to try to get the student to feel that there is just as much warm, inner satisfaction in taking a hemiplegic out of a wet bed and teaching him to walk and lead a life of some dignity and happiness outside an institution, and, as in one-third of the instances, to go back to some kind of gainful work.

There is just as much satisfaction in that accomplishment as there is in diagnosing a bizarre, rare disease that may be seen once in a medical lifetime, because, as it has been said by many authorities, that whether we like it or not 90 percent of the patients who seek services of the general physician have either problems of chronic disease or psychosomatic problems.

In modern life, physical wholeness is not necessary for a full life. Society for a long time has not paid for strength. It pays for what the individual has in his head and for the skill he has in his hands. Today we use only a fraction of our physical capacity in daily living or at work. But we carry this subconscious body image of physical perfection and ability as being synonymous.

In facing the problem of chronic disease and aging, probably the greatest preventive tool in our hands today is the use of stress. All of us live by stress. And if we order our lives to live under our stress reaction, our days are full, according to our own prescription and ability. We are stimulated physically, emotionally, and endocrinologically, and we set our whole lives subconsciously by this pattern. If we go too far beyond our stress end point, we are in trouble.

We also are in trouble if at a given period in life we say, or it is said to us, "Your work is finished. You go and sit and read and enjoy life." You cannot do this unless you have trained yourself to use stress in a new way, or in other words, you use the zest for life to set a new pattern for living.

If you are retired from your job, use the stress of community service, an avocation or other interests, for if you do not, your body will not have the stimulation physically, emotionally, and endocrinologically that it needs, and degeneration will promptly come.

This I believe to be the most important preventive course that we can take in finding the solution to the problem of aging until we learn the solution of arteriosclerosis, hypertension, and degenerative disease.

The Aging in the Community

It used to be that in psychiatry anyone over age 65 who had an illness was regarded as senile or arteriosclerotic. He was stored away, warehoused, simply taken care of.

It is found now that deterioration in age does not stem so much from a deterioration of vessels as it does from the fact that there is no longer a place in the community or in the home for the aging; so they retreat from reality, become depressed, and as the world passes them by, become confused.

We refuse to let this continue. Now we treat people up into their 80's and early 90's, with a fair return of these folks to the community.

—Dr. Francis J. Braceland, in a panel discussion at the diamond jubilee convocation of University Hospital.

Human Resources

brief

Basic public policies may be changed by selected findings of the Conservation of Human Resources Project and the National Manpower Council. With their focus on the significance of work to the individual and his environment, these findings are categorized with respect to physical health, mental health, and public health.

Although there is a general awareness among members of the medical profession about the close relations that exist between the soma and the psyche, studies of the ineffective soldier underscore the extent to which a weakened or

Based on a paper by Maj. Gen. Howard McC. Snyder, physician to President Eisenhower, Washington, D. C.

exhausted body serves as a host for emotional disturbance. We found this to be the case with soldiers riddled with malaria as well as as with soldiers who had been too long in the line, living in the mud and exposed to cold or the terrors of combat.

These same studies have sharpened our awareness of the dangers of a faulty personnel classification system, which assigns older men or men unaccustomed to physical strain to an infantry division for overseas duty. Unless men are given the opportunity to become hardened and unless recognition is taken of the fact that some men cannot be hardened, faulty assignment will lead to physical breakdown.

In our studies of occupational choice, we became acutely conscious of the stresses and strains, both physical and emotional, that confront most adolescents. Many young people are unable to cope effectively with the choices they face as regards their schooling and careers during these tumultuous years when they are being transformed from children into adults.

The book What Makes An Executive called attention to the fact that one of the distinguishing characteristics of leaders who reach the top by merit rather than by accident is the possession of a constitution which enables them to endure a grueling pace, to take punishment without breaking.

In connection with our efforts to deepen understanding of issues in the study of talent, we noted the heavy toll that deprivation can take during the early years of a child's life. Children with high potential at birth may show no sign of it by the time they enter school if they have been poorly fed, poorly housed, and otherwise poorly cared for. Deprivation and lack of stimulation at home can lead to lack of interest and apathy in school which sometimes even the best teachers cannot overcome. With the Nation ever more dependent on raising the level of skill and competence of the entire population, uninterested and lethargic pupils represent a major loss.

In our study of the Negro potential, we were impressed by the fact that in the period between World War II and the Korean War there were striking reductions in the incidence of venereal disease among young men both white and Negro with the most striking improvement found among the latter. There seems to be little question that as the educational and income level of a deprived group rises, the health of its members will show significant gains.

In a major study on womanpower, the finding is that of the 28 million women who worked last year in paid employment, 60 percent were married. Three million had children under age 6, and 5 million had children between ages 6 and 17. I have been speculating whether many of these women may not be stretching themselves beyond their health limits in holding down a job in addition to discharging their family responsibilities.

This same study calls attention to the fact that approximately 1 out of every 2 women who works is 40 or older. I was struck by this finding, for during World War II the War Department prohibited sending women over 40 overseas on the ground that they might soon become unsettled on entering the menopause. The new opportunities that many women have to work out of the home and to earn money may help them feel that they have a continuing constructive role through that period.

Work and Mental Health

One of the initial questions for the conservation project was why a million young men were rejected for military service during World War II on the ground that they were suffering from an emotional defect, and why another three-quarters of a million who had been accepted had to be separated prior to demobilization.

As was suggested in our monograph, Psychiatry and Military Manpower Policy, a distinction must be made between diagnostic categories and performance criteria in evaluating men. The fact that a psychiatrist finds that a man has a tic, is sometimes anxious, or suffers from sleeplessness may lead him to label the man as suffering from one or another type of emotional disturbance. But from a social point of view the much more important consideration is whether such a man can meet the performance standards prevailing in his civilian or military environment, that is, whether he can hold down a job, support himself and his family, stay out of trouble with the law, and continue to perform effectively.

Among the most interesting findings emerging from our detailed case analyses of soldiers who broke down in World War II are materials contributing to an understanding of psychosis. We found on careful inspection that many soldiers who were finally separated because of a psychosis had been more or less seriously ill from the day they entered the Army, but in one way or another their illness had not interfered with their performance of their major duties. Many of these men had performed sufficiently well to have been promoted to corporal or sergeant and had been able to serve for 2 or 3 years before their aberrant behavior caused the Army to take definitive action regarding them. In civilian life also where the pressures are usually less extreme, many people manage to adjust even though they may be suffering from one or another type of psychotic disturbance.

Our studies have led us to consider not only the conditions surrounding the breakdown of men in the armed services but also those influencing the readjustment to civilian life. As a result we are convinced that a man's emotional state should never be assessed independently of the environment in which he must function. His behavior and efficiency will in large measure be determined by the support which he receives from the small group and the larger organization within which he works. Mental illness frequently can be prevented or precipitated by the quality of the leadership and the wisdom or lack thereof of organizational policy.

The studies of the Negro soldier to which I alluded earlier alerted us to the way in which segregation in the armed services during World War II proved to be a seedbed for frustration and emotional illness, particularly with educated Negroes from the North who developed intense hostility to what they considered a grossly unjust system. Although it will be years before the full benefit of desegregation in the armed services will be manifest, remarkable gains can already be noted.

In our studies of life histories of soldiers who failed in World War II, we have reconstructed as well as possible the life of the soldier before he entered the service, his experiences in the Army, and his readjustment as a veteran. It soon became clear to us that the concept of basic adjustment can never deal solely with a man's strengths and weaknesses but must always include a simultaneous consideration of the demands and pressures in his immediate environment. A large number of men who had been able to make a tolerable adjustment in a civilian environment but who could not maintain the pace of an airborne division or even the discipline of military service were able, once they returned to civilian life, to reknit themselves and meet performance standards in their home communities.

Without further elaboration, the point can be made that mental health must never be approached as a static concept. There are great differences in environmental demands, and there are also great differences in the emotional resilience of people at different periods of their lives. We have been impressed with the strong drive that most people have to establish and maintain their emotional balance by getting and holding a job.

Work and Public Health

During World War II, 18 million men were screened for service. Almost 2 million, or 1 out of every 9 men aged 18 to 37, was found to be either a total illiterate, a borderline illiterate, or so poorly educated that he could not read instructions or write a letter. It is difficult indeed for such a person to take proper care of his own health or to know how to seek medical help when he requires it. The person who cannot read is cut off from much valuable information and advice about nutrition, health preserving measures, and effective therapeutic agents. As we found out in our studies of the uneducated, such people are also seriously handicapped in earning a decent livelihood, and it is exceedingly difficult to maintain effective health unless one can earn at least a modest income.

In many public discussions of compulsory military service, too little attention has been paid to the significant gains in health that are the indirect result of such service. The contribution of the Army in instructing soldiers in the prevention of venereal diseases during World War II was relayed to the home communities. Many soldiers had their first instruction in personal hygiene after entering the service.

In tracing the readjustment of soldiers who were separated prematurely from military service during World War II, we were impressed by the large number who rather quickly were able to rehabilitate themselves in civilian life. The availability of jobs of all kinds was a major aid especially because employers were willing in a tight labor market to be somewhat indulgent of the idiosyncrasies and disabilities of these veterans. Another helpful circumstance was the major support that many of these veterans received from their families, particularly from their wives.

Despite concern about the fact that so many mothers with young children at home hold down jobs, it was not possible for the National Manpower Council to do more than set this problem into perspective. However, I wonder whether we must not set off against the billions of dollars that these women earn the possible cost to the younger generation in being deprived of the loving care and supervision of their mothers.

With regard to the reasons why so many young men, almost 2 million, were emotionally incapable of serving effectively in the armed services of their country during a major war, most of the generalizations about the emotional health of the American public based on these data are not valid, as is made clear in our forthcoming study The Lost Divisions: Psychiatry and Manpower Logistics. Our data tell us more about the state of psychiatric thinking and screening than they tell us about the emotional health of the American public.

Impact on Policy

A wide range of policy considerations is affected by our studies: the expansion of opportunities for basic education for young and older persons; improved educational and occupational guidance in and out of the school system; improvements in our military manpower planning; reconsideration of selection and promotion policies in business; the more effective utilization of the potential of minority groups; and the alterations required to insure the full

Homesteads

If your great-aunt, who is 75, had an ununited fracture of the hip and had no home to go to, where would be the best place for her? "The hospital," you would say, by reflex.

I am not so sure that this is true. She would be awakened every morning at half-past six and told to hurry up and get washed and have her breakfast, that there were "sick" people in the ward that needed attention.

When she was in the middle of her favorite program she would be shushed because there are "sick" people in the ward. She hasn't been sick; she simply has not been able to walk. She has lived in an atmosphere of pain and death and people getting well and going home while she has been left behind. Like this mythical great-aunt, more than 2,500 patients out of 10,000 patients covered in a survey of New York City's general hospitals did not need continuing hospital care.

So we have set up "homesteads" to meet the needs of this group. In the homesteads, which are beds in general hospitals that are not being used, patients will need only the medical care they would need at home.

Each homestead will have a parent hospital; doctors will have office hours every morning; there will be someone for emergency calls if these people get sick; there will be no nurses. Well-trained attendants and recreation workers will give these people the priceless ingredient they have not had, and that is a little fun in life, with a beauty parlor and a snack bar, and a little music at night, and a work shop, and all the things that give something to these people to enjoy. They will give these people clinically necessary food plus the fun for about one-fourth of what it costs to operate an acute general hospital bed.

—Dr. Howard A. Rusk, in a panel discussion during the diamond jubilee convocation of the University Hospital.

development of scarce talents and skills on which the future progress and security of our Nation depends. These are but a few of the points of contact between our research and policy.

The Medical Center

brief

The term "medical center" is a relatively new one, perhaps born of the desire to claim size and preeminence as well as of the need to underline the concept of integration. The term has suffered some of the deterioration it perhaps deserved and "medical centers" have sprung up throughout the land, varying in size from a private association of a few physicians to great institutions such as the New York University-Bellevue Medical Center.

The medical center which we are discussing is defined as a large hospital with multiple clinical departments, research laboratories, and a program of medical education, usually in association with an undergraduate medical school. Such organizations existed long before the term "medical center" appeared.

The origins of medical centers are varied. Some began through the act of a legislature, some through a large private donation, and others by the often painful progress of reorganization and consolidation of existing institutions.

In considering the relationship of the medical center to the community it seems best to discuss first the beneficial aspect. Referring to no one center in particular, but to some ideal center distilled out of a partial knowledge of a number of such institutions, the medical center does provide a large share of the community's medical care. This may be measured by the number of surgical operations performed, of women delivered, of patient-bed days, or of outpatient department visits. Second, the center is the base for the early education of physicians. Finally, it is the site of most of today's medical research. Whether or not the medical center is the best type of organization for the purpose, the community must now look to medical centers for the personnel as well as the ideas for the medicine of today and the immediate future.

These contributions are so widely recognized that one can safely turn to a consideration of stresses that arise from certain characteristics of the modern medical center. The size and prestige of the center expose it to the criticisms met by any organization which is the largest unit in a competitive field. The tensions thus built up develop principally between the professional member of the center and his brother physician outside. They have been most intense where a new medical school is being developed in a relatively small community, with the effect that the established practitioner finds his career threatened.

To those responsible for the center, public reporting appears natural and indeed an obligation, but to the outside physician it may appear as an indirect means by which patients are channeled into the hands of the physicians who hold a center appointment. In cities where State universities have set up medical schools, strong objections have been raised that the favored physicians of the centers were eventually profiting from the public funds which provided them with exceptional facilities.

Such tensions are at their worst in the early years of an institution's history. As a new generation of physicians appear, its plans are made with the existence of the center taken into consideration. The physician of the community learns to live with and indeed cooperate with the medical center.

A second source of tension arises from the fact that the center is intrinsically an institution of specialization. This specialization is made necessary by the obligation of the center to carry on clinical investigation, a process which itself requires the segregation of groups of cases of a similar nature.

The layman is annoyed by the multiplication of physicians he must see and compensate before diagnosis and therapy and nostalgically longs for that somewhat legendary figure, the family doctor, who could treat practically anything at any time of the day or night. Responding to what does appear to be a genuine need, the outside physician is trying, with a

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Based on a paper by Dr. Howard C. Taylor, Jr., director of obstetrics and gynecology, Columbia Presbyterian Medical Center, New York City.

Today's Hospitals

Hospitals are the retailers that dispense the fruit of the laboratories. To illustrate the advances, 60 percent of all drugs prescribed in hospitals today were unknown 10 years ago. And only one-third of the space in a modern hospital is reserved for the patients; the rest is for all the modern technological equipment science needs on the firing line of therapy—scientific ammunition which requires an army of workers categorized by 200 different job descriptions.

—*From the summary remarks of Dr. Howard A. Rusk at the diamond jubilee convocation of University Hospital.*

considerable measure of success, to restore the prestige of general practice.

Here again, however, compromises have tended to soothe the conflict. Many physicians serve as specialists while functioning quite efficiently as general physicians. Furthermore, the center which is well adapted to its community has associated with it a large group of physicians, serving as part-time teachers, who are able to fill the role of the family physician and are capable also of conducting their patients through the intricacies of specialized diagnostic or therapeutic procedures.

Financial Aspects

Another characteristic of the center arises from the cost of its operation. Consideration of the sources of support will provide insight into the center's community relationships. The endowment fund of the private university or voluntary hospital, increased by unrestricted gifts from private sources, provides the basic support. The acquisition and amplification of such funds depend upon the devoted assistance and guidance of private individuals in the lay community.

The medical center must appear to be, and actually operate, as a continuation of the tradition of private American philanthropy for the care of the sick. This must somehow be managed in the face of current evidence that to the government is being delegated much of this burden. The center also must have such a program that intellectual interest alone will supply an important inducement to community backing.

Of growing importance is the indirect support provided by cooperation with municipal and State governments. This principle has been rapidly expanded in recent years so that none of our great metropolitan teaching centers are without such an arrangement.

Although the costs of operation of these city and State institutions may not appear on the books, these hospitals are in a real sense an integral part of the center. The financial contribution, particularly of municipal government, is enormous. The center must then constantly consider its relationship to the political leaders of the community.

As the number of the indigent in our country has diminished, hospitals and medical centers have been faced by the unexpected possibility of becoming partly or completely self-supporting on the basis of a vast increase in the fees paid to the hospital or its staff for services. This basically happy development has brought new problems of community relationships.

The improved income may alienate a public which still regards the center as a charitable institution. Controversy over the distribution of new sources of income may make the center appear as a competitor, not only of the practicing physicians in general, but even of its own professional staff. The financial arrangements for radiology, for diagnostic laboratories, and for anesthesia are a special source of contention. Requirements of simplicity indicate that these might be regarded as a part of hospital services, while, on the other hand, a number of medical organizations have pronounced the principle that these are indeed true professional services and not proper sources of hospital income. Insurance for professional services offers no special problem for private or semi-private patients, but has produced an unsolved dilemma in the case of the ward patient, for whom, in most New York hospitals, tradition has decreed that the attending physician accept no fee.

The support offered by Federal and voluntary health agencies for medical research in university medical schools and hospitals of the

country has largely appeared since 1945. Such support can be obtained with such ease that the research facilities of our medical centers have been strained to their utmost. The organization which is needed to develop and transmit applications for such research support and to administer the ever-enlarging research programs has produced a new set of relationships between the center and other institutions.

A final characteristic of the medical center is found in its generally experimental nature as an organization. The center is extraordinarily sensitive to new developments and to opinions, in the community, of organized medicine, institutions for the insurance of medical service, governmental agencies, or the general public.

For such reasons, the center is in the forefront of social and economic change in medicine. This characteristic adds to its basic importance and significance in the community. To the ultraconservative, the center may be the object of some suspicion and alarm; to the thoughtful and progressive, the center can be the source of inexhaustible interest as the place where productive controversy is most intense and where much that is new must be tested by trial.

Pan American Cooperation on Influenza

Members of the Advisory Committee on the World Health Organization Study Program for Influenza in the United States visited South America July 10 to 21, 1957, to stimulate special studies on epidemic influenza, and to set up channels for the interchange of information. The committee represents the Surgeons General of the Public Health Service, Army, Navy, Air Force, and the Office of the Secretary of Defense. At a meeting on August 13, which was devoted to a summary report of information obtained on the trip, the committee made the following recommendations:

In the event of epidemic influenza, the Public Health Service should be prepared to provide advisers and observers when requested by Brazil or other American countries through the Pan American Sanitary Bureau or the U. S. International Cooperation Administration.

A team of medical scientists should be available on the invitation of corresponding governments to undertake special studies of unusual problems in relation to epidemic influenza, in cooperation with local authorities in São Paulo, Buenos Aires, Montevideo, and Santiago.

Studies on epidemic influenza should be organized in the United States along lines similar to those being developed in South America. Appropriate organizations will require advance planning by a team of public health officers, physicians, and laboratory specialists in suitable communities or sections of communities. Studies at military bases should include dependents of military personnel to provide information on all ages and sexes.

Copies of appropriate material received from special studies sponsored by the Surgeons General of the Army, Navy, Air Force, and Public Health Service should be forwarded to the Pan American Sanitary Bureau for distribution to other countries through World Health Organization channels. Information is desired on age and sex specific attack rates and on the efficacy of vaccines, chemotherapy, and of chemoprophylaxis in complications.

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HEALTH EDUCATION in the Public Library

SIMON PODAIR and SAMUEL L. SIMON

THE PUBLIC LIBRARY, especially in urban areas, is rapidly becoming a center of community adult education. Health is a subject naturally adapted to a library adult education program. Its scope is universal; yet the problems it evokes can be brought home effectively to the participant in such a program. Although some libraries have full-blown, formalized adult education programs using the classroom approach, most offer activities of an informal nature: discussion groups, lectures, and forums. The well-publicized health program held in such a setting reaches a significant segment of the community; it attracts the unorganized members of the community, those who do not ordinarily attend meetings of formal groups, such as the PTA or the Rotary Club.

The Brooklyn Program

In 1956 a health education program was organized by the Brooklyn Office of the New York City Department of Health in cooperation with the Brooklyn Public Library. Sessions of the program were held monthly at local branch libraries from January through May. The library, with a central branch and 51 local branches throughout the borough, serves more than 2 million people. Independently administered, it is 1 of 3 library systems that cover the 5 boroughs of New York City.

Momentum for the program came from the Brooklyn office of the New York City Health Department, which approached the library's coordinator of work with adults in the fall of 1955 on the feasibility of health education for the public in the branch libraries. The suggestion was well received.

At an introductory meeting of interested branch head librarians, the health department's borough health education consultant and the library's coordinator of work with adults outlined the program and requested reactions from the librarians. Stressed at this meeting was the importance of local level planning by both agencies. The health education consultant also described the organization of the health department as being subdivided into district health centers, pointing out that each librarian in the program would be working with the public health educator at the local health center.

Those branch librarians who had shown interest in the program and district health educators of the health department were invited to a planning meeting at which definite duties were assigned. The health education staff agreed to recruit qualified speakers, discussion leaders, films, and appropriate literature, to obtain the cooperation of community groups, and to work closely with the branch librarian in organizing the particular neighborhood for the program. The branch librarian, in turn, accepted responsibility for reaching branch members and community groups, for physical arrangements of each meeting, and for acting as chairman of the program in his branch. The central branch of the library was responsible for overall publicity and the coordination of all branch programs. Publicity included a flyer, Highways To Health, distributed through the branches and the community, newspaper releases, radio spot announcements, and items in the monthly publication of the library, the *Brooklyn Public Library News Bulletin.* The borough health education consultant of the health department worked closely with the district health educators, assisting them with such problems as procuring speakers and techniques of organization.

Each district health educator met with his branch librarian to discuss the topics to be covered, based on the particular health needs of the district. The planning committees, including representatives of churches and PTA's, se-

Mr. Podair is borough consultant, health education, New York City Department of Health, and Mr. Simon serves as assistant coordinator of work with adults, Brooklyn Public Library.

lected topics for discussion in each area. Subjects included heart disease, cancer, nutrition, drug addiction, juvenile delinquency, emotional health of children, childhood diseases, alcoholism, adolescent problems, diabetes, poliomyelitis, and home safety.

Program speakers and discussion leaders were drawn from local and citywide sources. These included the local medical society, staff members of the health department, and voluntary agencies, such as the New York Heart Association and the Brooklyn Cancer Committee. Sixteen-millimeter films were obtained from the bureau of public health education of the New York City Department of Health. Staff nurses of the Visiting Nurse Association of Brooklyn distributed the flyers on their regular home visits.

For some programs, the library prepared book lists related to the topics under discussion. In addition, the branch librarian made book displays and spoke briefly on books pertinent to the program.

Community interest often went beyond district boundaries. The borough office of the New York City Department of Health, for example, received calls requesting information on the dates and places scheduled for discussion of specific topics. A voluntary agency cooperating in the program reported a request for information on specific local activities. To some meetings, daily newspapers sent reporters to cover the program, and in one instance, the news story that resulted was featured on the front page of the Brooklyn section of a leading metropolitan paper.

Fifty-five monthly programs were held in 13 branches, with a total attendance of 1,444. Approximately 1,000 more persons attended special programs for Spanish-speaking residents. These programs, held in areas with a high Spanish-speaking population, had the participation and support of the leaders of the Spanish-speaking community.

Agency Cooperation

As our program progressed, the advantages of cooperative planning between agencies became apparent. The complexity of organizing 55 health education programs during a 5-month period was reduced by using the staff skills and facilities of both agencies, that is, health education materials and resources of the health department and the effective publicity program of the library.

Another advantage came from workers in different fields attempting to meet the same problems. It became obvious that each group could gain valuable experiences through the approaches and insights of the other. This process of learning from each other was greatly enhanced by cooperative planning.

Also, the division of responsibility brought about economy since each agency did not have to assume full responsibility for staff time or financing.

Such planning placed an example before the community as a whole. The public could observe that planning between two large municipal agencies resulted in community service. Other agencies also became aware of the growth inherent in reaching out from the narrow confines of their own fields into joint programing with agencies in different but related fields.

A short audience evaluation questionnaire was distributed after each program to gauge audience reaction. Eighty-five percent of the evaluation forms distributed were returned to the branch librarians. Ninety-eight percent indicated that the programs were worthwhile and that the people attending would be willing to attend more of them. Many commented that the meetings were not held frequently enough. Critical comments included "did not enter the subject deeply enough," "would like to have seen a more recent film," or "noise of projector a little disturbing."

Sixty percent stated that they held library cards, indicating a fairly large attendance from segments of the community that ordinarily do not use library facilities, and pointing up the potentialities of the local library as an adult education center.

There was lack of continuity of attendance: Each meeting in the series at a particular branch attracted, in the main, different persons. A small core of individuals attended most of the series in their neighborhood branches. The largest attendance occurred at programs that

highlighted pressing community problems, such as mental health and juvenile delinquency. This emphasizes the importance of a study of community needs and backgrounds even before planning gets under way.

Audience participation in discussion at each program also can be considered a yardstick of evaluation. Such discussion for the most part covered a considerable section of the audience.

A firm base of voluntary cooperation has been established in health education programming between two large municipal agencies, a base that resulted from a fusion of concepts and techniques of a public health and an adult education agency. Through this program the public health workers who participated have tried to underscore the link between community health education and adult education.

Our prime conclusion is that the public library systems of our country offer an insufficiently explored but significant avenue of community health education.

publications

The Engineer in the U. S. Public Health Service

PHS Publication No. 455. Revised December 1956. 16 pages; illustrated.

This revised pamphlet, directed to college engineering students, stresses the opportunities and benefits of a career in the Public Health Service commissioned corps.

It describes in detail operations of the various programs and brings up to date the sections on research and development at the Robert A. Taft Sanitary Engineering Center, the Communicable Disease Center, the Arctic Health Research Center, the National Institutes of Health, the Occupational Health Program, and the work of sanitary engineers in civil defense and foreign service.

Health Manpower Chart Book

PHS Publication No. 511. 1957. By George St.J. Perrott and Maryland Y. Pennell. 59 pages; tables and charts. 25 cents.

Nearly 2 million persons are employed in occupations usually considered in the health field. This report presents in numerical and graphic terms information on certain characteristics of the health professions, with special emphasis on medicine, dentistry, and nursing. Personnel employed in health service industries and health occupations are shown, along with their age, sex, income, and length of work year.

For physicians, dentists, and nurses the numbers of practitioners and graduates are illustrated for selected years. The current number in each profession and the changes that have occurred within the last 30 years are given for States and regions. Urban-rural differences in supply and types of practice are discussed, along with gains and losses to the profession.

Tools for Evaluation of Cancer Nursing

For nursing instructors

PHS Publication No. 528. 1957. 21 pages. 25 cents.

Three tests for evaluating nurse behavior and knowledge in the field of cancer nursing are introduced in this monograph. They were developed in the last 5 years under the direction of Rosalie I. Peterson, chief, Nursing Section, Field Investigations and Demonstrations Branch, National Cancer Institute, and Dr. Louis Heil, director, office of testing and educational research, Brooklyn College.

The tests deal with cancer knowledge, nurse-patient relationships, and problem solving, respectively. The monograph also discusses the philosophy underlying the construction of the tests, reports the history of their development, briefly reviews the findings obtained in student and faculty testing programs, and comments on the validity and reliability findings.

The script of one "episode" from the nurse-patient relations test and six sample questions to familiarize the reader with the methodology employed in testing are contained in the appendix.

The complete data are published elsewhere.

This section carries announcements of all new Public Health Service publications and of selected new publications on health topics prepared by other Federal Government agencies.

Publications for which prices are quoted are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Orders should be accompanied by cash, check, or money order and should fully identify the publication. Public Health Service publications which do not carry price quotations, as well as single sample copies of those for which prices are shown, can be obtained without charge from the Public Inquiries Branch, Public Health Service, Washington 25, D. C.

The Public Health Service does not supply publications issued by other agencies.

Diarrheal Disease Control by Improved Human Excreta Disposal

L. J. McCABE and T. W. HAINES

THE EFFECT of fly control on the reduction of diarrheal disease has been demonstrated twice (*1*, *2*). In south Georgia, Lindsay, Stewart, and Watt (*2*) observed that the prevalence of *Shigella* infections was reduced during fly control activities. As long as flies were easy to control with DDT and other insecticides, an effective diarrheal disease control procedure was available, but the development of insecticide-resistant flies necessitated a closer examination of the fly's role in the transmission of diarrheal disease in the hope of finding another control procedure.

The exclusion of flies from their source of human enteric pathogens should prevent fly transmission of shigellosis. An experiment was therefore designed to measure the effect of excluding flies from contact with human excrement in an area where they had previously had ready access to such excrement. Flush toilets, water-carried sewage, and sewage treatment would have been the most effective method, but for the purposes of this study a cheap and easily effected alternative was necessary. An adaptation of the bored-hole latrine was used. This consisted of a hole 8 feet deep and 16 inches in diameter, covered with a concrete slab 4 feet square, with an aluminum riser, seat, and lid. The old privy structure was moved over the slab; if there had been no privy, the householder built a simple structure. (Details of design and construction are given on pp. 926–927.)

This privy rehabilitation program was conducted in Boston, Ga. (1950 population, 1,035). Boston had been included in an early fly control study (*2*). Until fly resistance made their use ineffective, DDT, dieldrin, and chlordane had been used there as residual sprays and DDT, as a space spray.

Plan of Study

All premises in the study town were inspected in January 1952 and notes were made of the excreta disposal methods used and their relative effectiveness. About half of the community was served by a sewerage system with treatment, which made the correction of disposal methods easier. Fifty-two percent of the 344 occupied dwellings had unsatisfactory facilities for excreta disposal, mostly surface privies. During April and May the excreta disposal facilities at 178 dwellings were improved by constructing a new privy or rehabilitating the old privy with an 8-foot-deep bored hole. At three dwellings it was necessary to renovate privies that were used by servants, and an additional 19 privies were remodeled at schools, churches, and commercial buildings.

Mr. McCabe, a sanitary engineer, is with the Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio. Mr. Haines, formerly with the Public Health Service, is with the Entomology Branch, Biological Warfare Laboratories, Fort Detrick, Frederick, Md. During the time of this study Mr. McCabe was assigned to the Epidemiology Unit, and Mr. Haines, to the Entomology Unit, PHS Communicable Disease Center Field Station, Thomasville, Ga.

This paper is the fifth in a series on control of diarrheal diseases.

Upon completion of the construction phase of the program, at no cost to the residents, all available excreta disposal facilities in Boston were satisfactory. Information leaflets were distributed through the schools and were left at each house where work had been done. These leaflets explained the program and requested cooperation in the correct use of the privies A notice was also stenciled on the seat lid to the effect that flies carry sickness and should be kept out of privies. Almost everyone used the privies because the units were a marked improvement, esthetically and otherwise, over previous facilities.

The method of making epidemiological observations of morbidity and *Shigella* prevalence before and after the privy rehabilitation program were the same as that used in a previous study (*2*). Blocks with a high proportion of children were selected for study. The families in the study blocks were visited monthly by trained lay enumerators, and histories of diarrheal disease were obtained for all family members. The average study population was 333, or about one-third of the community. Rectal swab cultures for the isolation of *Shigella* organisms were collected monthly from children under 10 years of age.

The evaluation of fly populations was a continuation of the entomological observations reported previously (*2*). A visual count method based on the Scudder grill was used. Representative blocks, consisting of about 15 percent of the total blocks, were sampled weekly and the five highest grill counts observed in each block were recorded. Observations were curtailed during the coldest weather when fly activity was minimal.

To obtain a measure of the contact of flies with human excreta, samples of privy contents were collected every 2 weeks from 10 percent of the privies in the community. The privies were selected at random, and each sample consisted of two quarter-pint portions. One portion was treated by brine flotation and the larvae were removed and identified. The other portion was held in an insectary and the insects that emerged were identified. At the time of sampling, observations were made of the condition of the privy, including a count of adult flies in the pit and in the privy structure. During the late months of the study, this schedule was reduced to sampling 5 percent of the privies in the community every third week.

For the purpose of comparison, similar epidemiological and entomological observations were made in three other towns—Pavo, population 806; Coolidge, population 764; and Meigs, population 1,125—where nothing had been done to the privies. The study populations in these towns were similar to the study population in Boston as to race and age distribution and environment.

Results

Remodeling the privies made a considerable change in the proportional distribution of flies breeding in them. The bored hole was very dark, and in half of the privies there was ground water in the hole. The relative frequency of fly breeding in unmodified privies and in the bored-hole privies is shown in table 1. *Hermetia illucens* and members of the Phoridae, Drosophilidae, and Culicidae were observed to be breeding more frequently as a re-

Table 1. Percentage of privies breeding insects in areas with unmodified privies and in an area with bored-hole privies, south Georgia, April 1952–March 1953

Unmodified privies [1]		Bored-hole privies [2]	
Insect	Percent privies	Insect	Percent privies
Hermetia illucens [3]	51. 2	*Hermetia illucens* [3]	59. 6
Ophyra spp	23. 0	Phoridae	11. 2
Sarcophaga spp	14. 8	Drosophilidae	6. 4
Fannia spp	10. 8	*Ophyra* spp	6. 1
Musca domestica	8. 7	*Psychoda* spp	5. 6
Psychoda spp	8. 3	*Sarcophaga* spp	4. 8
Muscina spp	5. 1	Borboridae	2. 9
Hydrotaea houghii	4. 8	Culicidae	2. 9
Dendrophaonia spp	3. 2	*Musca domestica*	1. 6
Borboridae	3. 1	*Muscina* spp	1. 6
Phoridae	1. 7	Scatopsidae	1. 6
Syrphidae	1. 6	*Milichella lactei-pennis.*	1. 6
Drosophilidae	1. 6	Phyllomyzidae	1. 3
Culicidae	1. 6	*Fannia* spp	1. 1
Sepsidae	1. 2	*Hydrotaea houghii*	1. 1
Scatopsidae	1. 0	All others	(4)
All others	(4)		

[1] Check towns, 939 samples.
[2] Boston, Ga., 377 samples.
[3] Stratiomyidae.
[4] Less than 1 percent each.

sult of the privy reconstruction, but the majority of the muscoid group showed a marked decrease. The amount of housefly (*Musca domestica*) breeding in privies had been similar in all the towns, but after privy remodeling there was a reduction in the percentage of privies breeding houseflies in Boston, and this rate of breeding is significantly lower than the rate of housefly breeding in the check towns (tables 2 and 3). On only eight occasions were the privies in Boston found to be breeding sites for houseflies after the program began, and the rate was low, 3.5 (larvae and reared adults) per half-pint sample of privy contents compared with 50.3 in samples taken from privies in the check towns.

The bored-hole privy was less attractive to houseflies than the unmodified privies. Adult flies were observed in the pit or privy structure only 4 percent of the 377 times samples were taken, with a median count of 2.5 flies for these times. In the check towns, the conditions were different—in the 939 samplings, houseflies were observed 31 percent of the time with a median count of 10.

The reduction of housefly breeding observed in rehabilitated privies had no appreciable effect on community fly populations. Since

Table 2. Unmodified privies—entomological and epidemiological observations, by climatic periods, south Georgia, April 1951–April 1952

Observations	Boston	Check towns			
		Total	Pavo	Coolidge	Meigs
	Warm weather (April–October 1951)[1]				
Privies breeding *Musca domestica*	(2)	(2)			
Grill count *M. domestica* [3]	30	28	36	21	
Shigella cultures [4]	382	915	355	281	279
Positive:					
Number	23	26	14	6	6
Percent	6.0	2.8	3.9	2.1	2.2
Diarrhea symptoms: [5]					
Person-months of experience	1,215	3,352	1,012	829	1,511
Number cases	21	68	28	10	30
Rate per 1,000	17.3	20.3	27.7	12.1	19.9
	Cool weather (November 1951–April 1952)[6]				
Privies breeding *M. domestica:* [7]					
Number sampled	164	196	126	45	25
M. domestica:					
Number	23	31	27	4	0
Percent	14	16	21	9	0
Grill count *M. domestica* [3]	11	15	13	21	12
Shigella cultures [4]	303	774	255	226	293
Positive:					
Number	9	30	15	13	2
Percent	3.0	3.9	5.9	5.8	0.7
Diarrhea symptoms: [5]					
Person-months of experience	[8] 1,246	[8] 3,212	994	614	1,604
Number cases	18	49	11	15	23
Rate per 1,000	14.4	15.3	11.1	24.4	14.3

[1] Mean monthly temperature 65° F. or more.
[2] Comparative data not available.
[3] Average third high grill count. Index of *M. domestica*, average of recorded monthly averages. In some months, particularly in cool weather, no counts were made. However, these omissions occurred in all towns and the counts are relative.
[4] Obtained by culturing rectal swabs of children less than 10 years old.
[5] Attack rates per 1,000 person-months of experience for total population in study area.
[6] Mean monthly temperature less than 65° F.
[7] Larvae identified and adults reared from a half-pint sample of privy contents.
[8] January–April 1952.

Table 3. Remodeled privies—entomological and epidemiological observations, by climatic periods, south Georgia, May 1952–October 1953

Observations	Boston [1]	Check towns, unmodified privies			
		Total	Pavo	Coolidge	Meigs
	Warm weather (May–September 1952)[2]				
Privies breeding *Musca domestica:* [3]					
Number sampled	186	459	121	177	161
M. domestica:					
Number	4	51	20	18	13
Percent	2	11	17	10	8
Grill count *M. domestica* [4]	32	52	28	83	44
Shigella cultures [5]	295	843	242	232	369
Postive:					
Number	10	46	21	20	5
Percent	3. 4	5. 5	8. 7	8. 6	1. 4
Diarrhea symptoms: [6]					
Person-months of experience	1, 568	3, 816	1, 222	768	1, 826
Number cases	16	78	26	27	25
Rate per 1,000	10. 2	20. 4	21. 3	35. 2	13. 7
	Cool weather (October 1952–April 1953)[7]				
Privies breeding *M. domestica:* [3]					
Number sampled	221	329	104	107	118
M. domestica:					
Number	3	15	10	5	0
Percent	1	5	10	5	0
Grill count *M. domestica* [4]	8	10	9	15	7
Shigella cultures [5]	316	1, 054	346	216	492
Positive:					
Number	2	32	13	0	19
Percent	0. 6	3. 0	3. 8	0. 0	3. 9
Diarrhea symptoms: [6]					
Person-months of experience	1, 752	5, 592	1, 547	1, 026	3, 019
Number cases	10	59	13	17	29
Rate per 1,000	5. 7	10. 6	8. 4	16. 6	9. 6
	Warm weather (May–October 1953)[2]				
Privies breeding *M. domestica:* [3]					
Number sampled	74	43	43	----	----
M. domestica:					
Number	1	4	4	----	----
Percent	1	9	9	----	----
Grill count *M. domestica* [4]	40	53	64	61	33
Shigella cultures [5]	293	872	285	200	387
Positive:					
Number	13	80	36	10	34
Percent	4. 4	9. 2	12. 6	5. 0	8. 8
Diarrhea symptoms: [6]					
Person-months of experience	1, 809	4, 976	1, 479	921	2, 576
Number cases	19	102	41	12	49
Rate per 1,000	10. 5	20. 5	27. 7	13. 0	19. 0

[1] All privies in Boston remodeled in April and May 1952.

[2] Mean monthly temperature 65° F. or more.

[3] Larvae identified and adults reared from a half-pint sample of privy contents.

[4] Average third high grill count. Index of *M. domestica*, average of recorded monthly averages. In some months, particularly in cool weather, no counts were made. However, these omissions occurred in all towns and the counts are relative.

[5] Obtained by culturing rectal swabs of children less than 10 years old.

[6] Attack rates per 1,000 person-months of experience for total population in study area.

[7] Mean monthly temperature less than 65° F.

Table 4. Shigella prevalence rates in areas with unmodified privies and with remodeled privies, south Georgia, April 1951–October 1953

Type of privy and area	Before privy remodeling (April 1951–April 1952)			After privy remodeling (May 1952–October 1953)			"P" (X^2 test)[1]
	Number rectal swab cultures	*Shigella* isolations		Number rectal swab cultures	*Shigella* isolations		
		Number	Percent		Number	Percent	
Bored-hole privies (Boston)	685	32	4.7	904	25	2.8	
Unmodified privies	1,689	56	3.3	2,769	158	5.7	$<.001$
Pavo	610	29	4.8	873	70	8.0	$<.001$
Coolidge	507	19	3.7	648	30	4.6	.05
Meigs	572	8	1.4	1,248	58	4.6	.025

[1] Probability that, in the postremodeling period, observed or greater difference in *Shigella* prevalence between the area with remodeled privies and the check towns would have occurred by chance. Probability that difference in *Shigella* prevalence rates between 1 year before to 1 year after privy remodeling periods in Boston, Ga., occurred by chance is 0.008–4.7 percent vs. 2.0 percent.

houseflies have been found to breed in a greater variety of media than have other common muscoid flies, it was to be expected that the reduction of breeding in one medium would have little effect (*3*). The average fly counts, by climatic periods, are shown in tables 2 and 3. Lindsay, Stewart, and Watt (*2*) observed that the increase in *Shigella* transmission came after they lost control of houseflies when the other fly species were still controlled. Consideration has been given to the housefly because small numbers of other fly species were observed in these communities; during the study period, the average monthly count for all other species was 1.3 flies.

During the 18 months of observations after the privy remodeling program was completed, Boston had a significantly lower rate of *Shigella* infections than it had before the program, 2.8 percent vs. 4.7 percent (table 4). In this comparison, two-thirds of the postprogram data taken were obtained during warm weather, whereas only 7 of the 13 months in the preprogram period were the warm months commonly associated with higher rates of *Shigella* infection. The infection rate in Boston was higher than in the check towns for the 13 months before the program (4.7 vs. 3.3 percent), but after the privies were remodeled the Boston rate was lower (2.8 vs. 5.7 percent), as shown in table 4.

The number of persons reporting diarrhea as a symptom of illness is shown in tables 2 and 3. After the excreta disposal methods were improved, the reported diarrhea rate in Boston was only half as high as in the check towns.

Discussion

The bored-hole privy of the design used in this study did not exclude all houseflies from human excreta, but its low attractiveness to houseflies did mitigate this problem somewhat. Deficiencies noted in the design were that the size of the riser permitted fouling of the inside rear of the riser and that, in some of the privies, portions of the contents were floating on the high ground water.

The reduced housefly breeding observed in the bored-hole privies in Boston, where the fly had become highly resistant to the hydrocarbon insecticides, is more remarkable in light of recent ecological studies. In unpublished data, Lindsay states that during studies conducted in Hidalgo County, Tex., in 1946, "not a single housefly was reared from material from anything resembling a pit privy although surface samples frequently were producers." More recently, results from housefly breeding surveys following treatment with hydrocarbon insecticides in the same general areas as well as in other areas, have shown decided increases in housefly production from privy pits (*4–6*).

Results of this study show the approximate maximum level in the reduction of *Shigella* transmission that can be obtained and maintained by the use of good privies alone. With

a water-carried excreta disposal system, the exclusion of flies from human excreta would be more effective than with privies. Also, when water-carried excreta disposal methods are installed, hand-washing facilities usually are also made more available, and the availability of water has been shown to have an influence on rates of *Shigella* infections (*7*, *8*). It would be difficult to assess the effect of a water-carried excreta disposal system only, except in an expensive controlled study.

The various recognized mechanisms of transmission of *Shigella* need evaluation in order to develop the best diarrheal disease control program. It is now possible to compare the relative effectiveness of two control procedures: fly exclusion using bored-hole privies, as reported here, as opposed to reduction of fly population with chemicals, as performed in Texas (*1*) and Georgia (*2*). The Georgia studies virtually eliminated flies from the environment, thereby providing an estimate of the effect of complete

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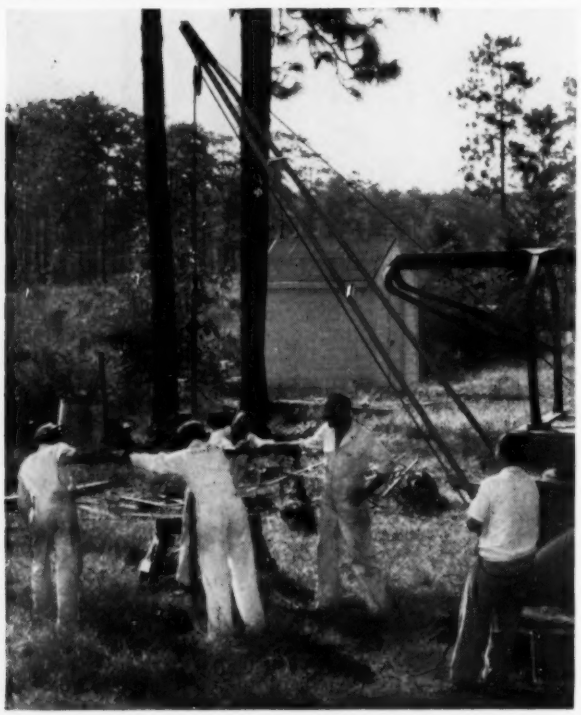
design and construction OF BORED-HOLE PRIVIES



Some of the techniques of privy design and construction presented here may be helpful in rural sanitation programs since the privy will continue to be an important means of excreta disposal in the United States for some time, and in many sections of the world it may be the principal method used. The 1950 census of housing reports that 8,900,641 rural dwellings in this country did not have flush toilets inside the structure, and over 2 million urban dwellings did not have flush toilets.

The bored-hole privy used in this study is an adaptation of the bored-hole latrine 18 to 20 feet deep used by the Rockefeller Foundation in the Philippines. The same type of Iwan 16-inch latrine borer was used. An **A**-frame was constructed on the rear of a pickup truck to hoist the auger out of the hole as the bucket filled (fig. 1). The shaft on the auger was 12 feet long with a crossarm that could be raised as the digging progressed. A crew of 5 men, a carpenter and 4 laborers, bored the hole and set a precast concrete slab over it. Minimal repairs were made to the old privy structure, which was moved to the new location (fig. 2). The privy contents at the old location were buried.

The concrete slabs for the remodeled privies were made 4 feet square and reinforced so that they could be used later on standard pit privies. The slabs were made by pouring ready-mixed concrete into a series of forms at a central site. Later the slabs with the embedded risers were hauled to the location where they were to be used. The truck used to transport the slabs was equipped with an old bomb hoist to facili-

◀ **Figure 1**

exclusion of flies from human excreta. Applying the statistical method used by Francis (*9*) in evaluating the effectiveness of poliomyelitis vaccine, the bored-hole privy technique had an estimated effectiveness of 52 percent in reducing *Shigella* infection rates. This compares with 61 percent in Texas and 67 percent in Georgia when chemical fly control techniques were used. (The lower 95-percent confidence limits of findings in these areas were 33, 55, and 44 percent effectiveness, respectively.) In each of the above studies, some *Shigella* was transmitted during the test period by the other mechanisms. The effectiveness of controlling these other mechanisms should be determined. Increased water availability would decrease the prevalence of dirty hands, for example.

Summary

All privies in Boston, Ga. (population 1,035), were reconstructed in the spring of 1952 by

Figure 2 ▶

Figure 3 ▶

tate loading and positioning the slab over the hole.

The aluminum riser, seat, and lid were a unit used by the Georgia Department of Public Health in their improvement programs. The riser was 14 inches in diameter with a stamped metal seat mounted at the top. The lid was hinged at the back and covered the hole and seat completely. It is recommended that the riser be redesigned in the shape of a truncated cone, with the projection to the rear, to minimize fouling.

Curbing of the hole in areas of high ground water is also recommended. In clay, the wall of the hole did not slough off, but if ground water came up to the topsoil, caving of the wall was noted.

The cost of a typical privy (fig. 3) was $26.20. Of this, $11.06 was for material and equipment and $15.14 for approximately 12 hours of labor. This cost is itemized below.

Equipment		$4.04
Truck depreciation	1.02	
Truck operation expense	1.46	
A-frame and augers	.91	
Labor (0.53 hours)	.65	
Slab and riser		10.41
Forms	.12	
Concrete and steel	2.70	
Aluminum riser, seat, and lid	4.85	
Labor (1.94 hours)	2.74	
Digging hole, setting slab, and moving old privy		10.85
Labor (8.97 hours, range 5–19 hours)		
Travel between privies		.90
Labor (0.74 hour)		
Total		$26.20

drilling bored holes 8 feet deep. This markedly curtailed housefly breeding in privies but did not significantly reduce the housefly population in the community. Epidemiological observations were continued for 18 months following the privy remodeling. From rectal swab cultures taken monthly, a significant reduction of *Shigella* infections was observed in children less than 10 years old. Also, after improvements were made in the methods of excreta disposal in the community, the reported diarrheal disease rate in Boston was one-half the rate observed in the check towns.

REFERENCES

(*1*) Watt, J., and Lindsay, D. R.: Diarrheal disease control studies. I. Effect of fly control in a high morbidity area. Pub. Health Rep. 53: 1319–1334, Oct. 8, 1948.

(*2*) Lindsay, D. R., Stewart, W. H., and Watt, J.: Effect of fly control on diarrheal disease in an area of moderate morbidity. Pub. Health Rep. 68: 361–367, April 1953.

(*3*) Haines, T. W.: Breeding media of common flies. II. In rural areas. Am. J. Trop. Med. & Hyg. 4: 1125–1130, November 1955.

(*4*) Schoof, H. F., and Silverly, R. E.: Privies as a source of fly populations in an urban area. Am. J. Trop. Med. & Hyg. 2: 930–935, September 1954.

(*5*) Kilpatrick, J. W., and Bogue, M. D.: Adult fly production from garbage can sites and privy pits in the Lower Rio Grande Valley. Am. J. Trop. Med. & Hyg. 5: 331–339, March 1956.

(*6*) Kilpatrick, J. W., and Schoof, H. F.: Fly production in treated and untreated privies. Pub. Health Rep. 71: 787–796, August 1956.

(*7*) Holister, A. C., Beck, D., Gittelsohn, A. M., and Hemphill, E. C.: Influence of water availability on *Shigella* prevalence in children of farm labor families. Am. J. Pub. Health 45: 354–362, March 1955.

(*8*) Stewart, W. H., McCabe, L. J., Hemphill, E. C., and DeCapito, T.: Diarrheal disease control studies. IV. The relationship of certain environmental factors to the prevalence of *Shigella* infections. Am. J. Trop. Med. & Hyg. 4: 718–724, July 1955.

(*9*) Francis, T., Jr., Korns, R. F., Voight, R. B., Boisen, M., Hemphill, F. M., Napier, J. A., and Tolchinsky, E.: An evaluation of the 1954 poliomyelitis vaccine trials. Am. J. Pub. Health 45: May 1955, part 2, p. 62.

Medical Research Fellowships

The division of medical sciences of the National Academy of Sciences–National Research Council has announced a program of postdoctoral research fellowships for 1958–59. Applications for the fellowships, which will be awarded in the late winter, will be accepted until December 1, 1957.

The fellowships fall into three categories: the National Research fellowships in the medical sciences offering research experience in the basic medical sciences for persons preparing for careers in academic medicine and investigation; the Donner fellowships for medical research for full-time research at the fundamental level; and fellowships in radiological research, administered for the James Picker Foundation by the division's committee on radiology, for the development of research skills leading to investigative careers in the field of radiology.

Candidates for all three fellowships must hold an M.D., Ph.D., or Sc.D. degree or the equivalent, and should ordinarily not be more than 35 years of age. Applicants for the NRC and Donner fellowships must be citizens of the United States or Canada.

Details and application blanks may be obtained from the Division of Medical Sciences, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW., Washington 25, D. C.

The investigation of the Baton Rouge outbreak provides a model of procedures recommended by the International Association of Milk and Food Sanitarians.

An Outbreak of Gastroenteritis in a Louisiana School

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ON October 12, 1956, the Louisiana State Department of Health and the East Baton Rouge Parish Health Unit were alerted to an outbreak of "food poisoning" among the students of a Baton Rouge high school by a radio announcer broadcasting a night football game between the school and a school near Lake Charles.

Health authorities in Lake Charles and the supervisor of the Baton Rouge high school cafeteria were contacted immediately. The director of the Calcasieu Parish Health Unit, after investigation, reported that the students were being hospitalized in Lake Charles and Sulphur, La., that the attending physicians were of the opinion that the illness was food poisoning, and that some of the students said that they had become ill before leaving Baton Rouge. The supervisor of the cafeteria stated that a number of students became ill Friday morning, but that she and the school principal thought they had a virus infection and so did not report the occurrence to the Parish health unit. She also stated that none of the foods from the Thursday menu were available for samples and that all leftovers, as well as the cans and their labels, were destroyed.

Determining Origin

Saturday morning, the staff of the East Baton Rouge Parish Health Unit, headed by Dr. David E. Brown, and the epidemiology team of the Louisiana State Department of Health began their investigation.

It was determined that most of the affected persons had onsets during Thursday night and Friday, suggesting a common source of illness on Wednesday or Thursday, October 10 or 11. The most likely common source was one of the noon meals served at the school cafeteria. A list of all persons preparing and handling food in the school cafeteria on Wednesday and Thursday and copies of the menus for these days were obtained.

A sanitation survey was made of the entire school plant as well as the food-handling area. Particular efforts were made to find evidence of cross connection or back siphonage in the water distribution system of the school. Water from the school is supplied by the Baton Rouge water works. A service line to the school issues from a 17-inch main. Water pressure is high and does not fluctuate. The water works company's records showed, moreover, that it had

The authors are all with the Louisiana State Department of Health, where Dr. Martin serves as chief, and Miss Martine, nurse epidemiologist, of the epidemiology section. Dr. Caraway is a veterinary epidemiologist, and Mr. Orgeron, a sanitarian epidemiologist. The department's division of laboratories, directed by Dr. George H. Hauser, assisted in the study.

not had a service call from the school for several months nor had the water been cut off in that area for some time. The school authorities affirmed that there had been no plumbing or repair work at the school during the current term. Eight samples of water collected at different points on the first and second floors of the school building were reported negative for coliform organisms. Portions of the foods in stock were collected and submitted to the State department of health laboratory for bacteriological and toxicological studies.

Monday morning, October 15, questionnaires were distributed to the students and faculty at school with the request that they be completed and returned as quickly as possible. These questionnaires were designed to gather information of epidemiological significance. The support and help of the principal permitted completion of this task with ease by early afternoon.

The public health nurses contacted the food handlers and a number of the students Monday morning to obtain stool specimens for study. These were submitted to the State department of health laboratory to be studied for organisms of the food poisoning types.

A total of 1,105 questionnaires were completed and returned by 35 members of the faculty and 1,070 students. The assistant principal advised us that 121 students were absent on this Monday compared with 95 on the preceding Monday. Two hundred sixteen persons did not eat any food in the school cafeteria on either Wednesday or Thursday, 16 drank only milk and 873 ate one or more of the items on the menu other than milk and in many instances including milk.

Of the 216 who did not eat in the cafeteria, 21 (9.6 percent) became ill between October 11 and October 14, with symptoms of gastroenteritis; 2 (12.5 percent) of the 16 who drank only milk had similar symptoms while 453 (51.8 percent) of the 873 who ate in the cafeteria had symptoms of gastroenteritis. Only 58 of 998 persons ate elsewhere with friends who were also made sick. Authorities of nearby schools revealed no unusual absenteeism. These findings indicated that the cause of the illness was associated with the school cafeteria.

During the study period, 83 persons were sick enough to see a doctor and 40 had to be hospitalized. The principal manifestations were nausea in 342 cases (78.8 percent), weakness in 285 (66.9 percent), vomiting in 194 (46.3 percent), fever in 189 (44.5 percent), diarrhea in 179 (42.5 percent), chilly sensations in 153 (36.5 percent), rigors in 36 (8.6 percent), and other

Table 1. Attack rates by category of food eaten in the cafeteria of a Baton Rouge high school, Oct. 10 and 11, 1956

Noon meal	Persons eating food item				Persons not eating food item			
	Total	Ill	Well	Attack rate	Total	Ill	Well	Attack rate
Oct. 10, 1956								
Meat loaf	726	408	318	56. 2	102	24	78	23. 5
Potatoes	679	367	312	54. 0	149	65	84	43. 6
Carrot salad	388	244	144	62. 9	440	188	252	42. 7
Apple pie	728	381	347	52. 3	100	51	49	51. 0
Bread	732	384	348	52. 5	96	48	48	50. 0
Milk	786	406	380	51. 7	42	26	16	61. 9
Oct. 11, 1956								
Pork and gravy	711	409	302	57. 5	97	23	74	23. 7
Coleslaw	353	229	124	64. 9	445	203	242	45. 6
Green beans	509	303	206	59. 5	299	129	170	43. 1
Rice	701	395	306	56. 3	107	37	70	34. 6
Cake and chocolate pudding	687	376	311	54. 7	121	56	65	46. 3
Bread	712	386	326	54. 2	96	46	50	47. 9
Milk	775	413	362	53. 3	33	19	14	57. 6

Table 2. Attack rates by combination of foods eaten in the cafeteria of a Baton Rouge high school, Oct. 10 and 11, 1956

Food	Persons eating food item			
	Total	Ill	Well	Attack rate
Meat loaf and/or pork and gravy	804	444	360	55. 2
Meat loaf, no pork and gravy	97	37	60	38. 1
Pork and gravy, no meat loaf	81	37	44	45. 7
No meat loaf, no pork and gravy	69	9	60	13. 0
Carrot salad, no meat loaf and no pork and gravy	21	4	17	19. 0
Coleslaw, no meat loaf and no pork and gravy	11	0	11	0
No carrot salad, coleslaw, nor meat	46	5	41	10. 9
Carrot salad and/or coleslaw, and both meats	354	237	117	66. 9
Both meats but no carrot salad nor coleslaw	272	133	139	48. 9
Carrot salad or coleslaw but no meat	22	4	18	18. 2

symptoms in 8 (1.8 percent). Of those affected, 29.2 percent were sick less than 1 day, 47.9 percent more than 1 day and less than 2 days, 16 percent more than 2 and less than 3 days, and 6.9 percent more than 3 days. As nearly as we can determine, the incubation period was 32 to 72 hours.

Attack Rates

Attack rates were calculated for the different foods eaten (tables 1 and 2). These rates suggested that some persons became ill from food eaten Wednesday and others from food eaten Thursday. Investigation revealed that the meat loaf served on Wednesday was prepared from fresh meat and canned pork and gravy. Canned pork and gravy from the same company, but not leftovers, was served on Thursday. The attack rates strongly suggested that the meat loaf, the pork and gravy, the carrot salad, the coleslaw, or all of these, may have been the offending food.

Analysis shows that the attack rate for those who ate meat loaf on Wednesday and pork and gravy on Thursday are very similar (56.2 percent and 57.5 percent). There is also a close correlation between attack rates of those persons who did not eat these foods (23.5 percent and 23.7 percent). The difference in attack rates is even more pronounced when a tabulation is made of those persons who ate either or both meat loaf and pork and gravy. About 55 percent of such persons became ill, whereas only 13 percent of those who ate neither food became ill. By the development of other rates, we were able to exclude the salads as probable offending foods. The attack rate for those who had either the carrot or coleslaw salad, but neither meat dish, was 18.2 percent as compared with an attack rate of 48.9 percent for those persons who had both meats, but neither salad. The significance of these differences was tested and it was found that this difference would occur only once in a million times by chance alone.

We have now established that those persons who ate either or both meat loaf and pork and gravy in the school cafeteria on Wednesday or Thursday and became ill did so in a significantly greater number than those who did not eat those meats in the school cafeteria on the 2 days.

Since leftovers of the suspected foods were not available, similar foods of the same manufacturer's lot number were collected and tested by cultural methods, animal feeding, and by serving to human volunteers. No organisms were cultured from these foods and none of the test animals or test humans became ill. This suggests the probability of these foods being inoculated with a pathogenic agent or a toxic substance after opening of the can. Investigation failed to reveal any likelihood of contamination with an insecticide, rodenticide, or other chemical. No pathogenic agent was identified in any of the stool specimens submitted by each of the food handlers and a number of students.

Two persons prepared and two different persons served the meat loaf on Wednesday. Thursday, the cans of pork and gravy were

opened by 2 persons, cooked by 1 person, and served by 2 people. One of the persons who opened the cans of pork and gravy cooked this food on Thursday; she is also 1 of the 2 who prepared and cooked the meat loaf on Wednesday. One of the two persons who served the pork and gravy on Thursday also served the meat loaf on Wednesday. If the meat loaf and the pork and gravy were contaminated after opening of the cans of pork and gravy, it seems likely that one of these two people inoculated the pork and gravy, and most probably it was the person who prepared and cooked the meat loaf and the pork and gravy. This is a supposition, not an established fact, however, as none of the usual food poisoning organisms were cultured from the persons who were ill or from the food handlers. This might be accounted for, however, by the failure to suspect the saprophytic organisms such as *Escherichia coli* or *Bacillus proteus* as a cause of the outbreak and to do the studies necessary for identifying these organisms. The possibility of a virus being the offending organism must also be considered as virus isolation studies were not performed. Also, the stool specimens submitted may not have been from the person submitting the specimen, especially if that person had recently been ill of a diarrheal disease and was afraid of being incriminated. Unfortunately, dyed lycopodium spores were not given to the suspected food handlers to allow identification of the stool specimens submitted. As the stool specimens submitted are subject to question, so is the illness history of the food handlers.

On a return visit to the school cafeteria, several kitchen workers were questioned. Evidence gathered suggested that some foods are being held over from one day to the next and served. On October 17, 1956, approximately 50 pounds of pork and gravy were found. This had just been removed from the freezer and was being discarded in the garbage. We were not able to determine whether this batch of pork and gravy was part of that which was served on Thursday. Samples were collected and submitted to the laboratory for study. No food poisoning organisms were isolated.

Summary and Recommendations

In summary, 51.8 percent of those persons who had their noon meal in a high school cafeteria in Baton Rouge on either or both Wednesday and Thursday, October 10 and 11, 1956, became ill with gastroenteritis after an incubation period of approximately 32 to 72 hours. Presumably the offending foods were meat loaf (containing pork and gravy) and pork and gravy. How these foodstuffs became contaminated and the identity of the infective agent was never established.

The following recommendations are the result of the investigation:

- Any disease occurrence of unusual magnitude or severity, regardless of what is thought to be the cause, should immediately be reported to the health officer having jurisdiction.
- When food is suspected as the vehicle of infection, every effort should be made to secure representative samples of the suspected food. When available, samples should be taken from the leftovers on plates of those affected as well as from the bulk food and submitted to the laboratory for cultural and toxico-chemical studies.
- Specimens of the vomitus and stools of patients suspected of being ill from ingestion of a suspected food should be collected and submitted to the laboratory for isolation of food poisoning or food infection micro-organisms or of a toxic substance.
- We should broaden our concept of food poisoning to include food infection by other agents which we have long believed to be saprophytic, but which recent investigations have demonstrated or suggested to be the causative agents of gastroenteritis.
- In addition to the usual sanitary inspection of plant and equipment we should concentrate our educational and investigational efforts on food-handling practices so as to establish and maintain safe methods of operation.
- The person responsible for the operation of a food-handling establishment should be taught the importance of a daily investigation of the health status of each of his employees and should be expected to exclude from work any individual who is sick or who has a discernible skin infection.

Accuracy of the Reported Causes of Fetal and Neonatal Deaths

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CAUSE-OF-DEATH statistics obtained from fetal and neonatal death certificates provide a means by which health departments can contribute to investigations of perinatal wastage. It is important, therefore, to be aware of the limitations of such statistics.

This paper reports a study of the accuracy of the causes of perinatal deaths given on death certificates submitted to the Baltimore City Health Department by the Johns Hopkins Hospital during 1953 (calendar year). One hundred and twenty-seven deaths are included; 50 were fetal deaths, and 77 were early neonatal deaths (70 during the first week of life and 7 during the second week).

An investigation of the accuracy of the reported causes of perinatal deaths implies that there is available a statement of the real cause of death with which the reported cause can be compared. No claim is made that the true cause of death was known for each of the deaths in this study, but it was possible to obtain a reasonably good substitute.

During 1953 the perinatal autopsy rate at the Johns Hopkins Hospital approached 100 percent. The pathological data obtained at autopsy and the clinical history for each death in this study were reviewed by obstetricians and pediatricians at an infant mortality conference. The results of the conference discussion, together with the pathology report and the clinical history, were used as a basis for determining the cause of the fetal or neonatal loss. This cause was posted to a death certificate, designated the "special certificate," of the type used by the Baltimore City Health Department in 1953. For this study, it was assumed that the information recorded on the special certificate represented the best available approximation of the true cause of death.

The original certificate for each death was in the files of the Baltimore City Health Department and was not seen by the physician who completed the special certificate. The physician who completed the original certificate had access only to the clinical history and possibly gross pathological findings. Exactly what information was used in preparing each of the original certificates is not known.

All causes of death were coded in accordance with the International Statistical Classification of Diseases, Injuries, and Causes of Death (sixth revision). The special certificates were coded by the same nosologist who had coded the original certificates in 1953.

Accuracy of the original certificates was measured by the percentage of the deaths studied in which the reported cause agreed with the cause given on the special certificate. Agreement was determined from a comparison of the international statistical classification code numbers assigned to the causes given on the special and the original certificates.

For fetal deaths two degrees of agreement were established. The first, which represents a high degree of matching, required agreement in the first two digits of the code. For example, a certificate ascribing a fetal death to difficult

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labor with abnormality of the bones of the pelvis, coded Y34.0, was considered in agreement with its companion certificate if it attributed death to difficult labor without mention of the underlying condition, coded Y34.6. The second, and more liberal appraisal of agreement, was based on three broad groups of causes of fetal death, namely, causes and conditions in the mother; causes determined in fetus, placenta, and cord; and unknown or ill-defined causes.

Agreement for the causes of neonatal death was determined from a comparison of the special and original certificates according to the rubrics used in the annual report of the Baltimore City Health Department for 1953. These rubrics were as follows: congenital malformation, birth injury, postnatal asphyxia and atelectasis, infection of the newborn, hemolytic and hemorrhagic disease of the newborn, immaturity, and all other causes. The analysis of the accuracy of the causes of neonatal death was complicated by the fact that the classification hyalinelike membrane appeared on the special certificates but was not used at the time the original certificates were prepared.

Fetal Deaths

Agreement between the special and original certificates was 60 percent for fetal deaths; that is, the causes agreed for 30 of the 50 cases studied (table 1). Sixteen of the special certificates ascribed fetal death to causes and conditions in the mother. Of these, only six were matched by the causes given on the original certificates. Thus, the percentage agreement for this group of causes was about 38. Five of the unmatched cases were in the category "toxemias"; two were in "difficulties in labor"; one was in "chronic disease"; and the remaining two deaths were attributed to other causes and conditions in the mother.

There were 18 fetal deaths ascribed on the special certificates to causes determined in fetus, placenta, and cord. Thirteen, or 72 percent, of the original certificates for these deaths gave the same cause. Premature separation of the placenta was the cause for 3 of the 5 nonmatching cases.

For the 16 deaths from unknown or ill-defined causes, 11, or 69 percent, were assigned to this category on the basis of the original certificates. Three of the five nonmatching deaths were ascribed to causes and conditions in the mother on the original certificates.

These results indicate that fetal deaths due to causes and conditions in the mother are inaccurately reported more frequently than deaths due to conditions determined in the fetus. However, the size and scope of this study are such that this generalization must be considered guardedly. The 50 fetal deaths

Table 1. Comparison of the causes of fetal death given on special and original death certificates, Baltimore City, Md., 1953

Cause of death according to special certificate [1]	Total	Cause of death according to original certificate									
		A1	A2	A3	A4	B1	B2	B3	B4	B5	C
Total	50	2	4	1	3		11	4	1	1	23
A. Causes and conditions in mother:											
1. Chronic disease (30.0–30.5)	3	2									1
2. Toxemias (32.3, 32.4)	7		2				1				4
3. Difficulties in labor (34.0–34.6)	2										2
4. Other (31.0–31.4, 32.0, 32.2, 32.5, 35.0–35.2)	4				2						2
B. Causes determined in fetus, placenta, and cord:											
1. Placenta previa (36.1, 36.3)	1						1				
2. Premature separation (36.2, 36.4)	11		1				8				2
3. Other placenta and cord (36.0, 36.5, 36.6)	4							4			
4. Congenital malformation (38.0–38.7)	1								1		
5. Erythroblastosis (39.2)	1										1
C. Unknown or ill-defined (35.3, 39.4–39.6)	16		1	1	1		1			1	11

[1] Numbers in parentheses are international statistical classification code numbers, with Y prefix omitted.

Table 2. Number and percentage of fetal deaths by cause for study deaths and all deaths [1] in Baltimore City, Md., 1953

Cause of death [2]	Number			Percent		
	Study		Baltimore City	Study		Baltimore City
	Special certificate	Original certificate		Special certificate	Original certificate	
All causes	50	50	391	100.0	100.0	100.0
Causes and conditions in mother	16	10	65	32	20	16.6
Chronic disease (30.0–30.5)	3	2	11	6	4	2.8
Toxemias (32.3, 32.4)	7	4	28	14	8	7.2
Difficulties in labor (34.0–34.6)	2	1	11	4	2	2.8
Other (31.0–31.4, 32.0, 32.2, 32.5, 35.0–35.2)	4	3	15	8	6	3.8
Causes determined in fetus, placenta, and cord	18	17	145	36	34	37.1
Placenta previa (36.1, 36.3)	1	0	0	2	0	0
Premature separation (36.2, 36.4)	11	11	76	22	22	19.4
Other placenta and cord (36.0, 36.5, 36.6)	4	4	35	8	8	9.0
Congenital malformation (38.0–38.7)	1	1	17	2	2	4.3
Erythroblastosis (39.2)	1	1	16	2	2	4.1
Birth injury (37.0–37.8)	0	0	1	0	0	0.3
Unknown or ill-defined (35.3, 39.4–39.6)	16	23	181	32	46	46.3

[1] Deaths after 20 weeks or more gestation.
[2] Numbers in parentheses are international statistical classification code numbers, with Y prefix omitted.

were purposively selected from a total of 391 deaths (20 weeks or more gestation) that occurred in Baltimore City during 1953. Moreover, they are all from one teaching hospital. It is of interest, therefore, to compare the distribution of the causes for the study deaths with the distribution of the causes for all fetal deaths in the city during the same period. The comparative data are shown in table 2.

Twenty percent of the study deaths were ascribed to causes in the mother on the original certificates, compared with 16.6 percent of all fetal deaths. For causes in the fetus, placenta, and cord, the percentages were 34 for the study group and 37.1 for all deaths; for unknown or ill-defined causes, they were 46 and 46.3. Thus, for these broad groups the largest percentage difference between the study deaths and all deaths is less than 4. It seems fair to say, therefore, that, with respect to causes of death, the sample is representative of the total fetal death experience in Baltimore during 1953.

A comparison of the percentage distributions of the causes given on the special, the original, and all certificates shows the following:

1. Fetal deaths were ascribed to causes and conditions in the mother about twice as often on the special certificates as on either the original certificates or on the certificates for all fetal deaths.

2. The frequency of causes determined in fetus, placenta, and cord was about the same for the three sets of certificates.

3. Fetal deaths ascribed to unknown or ill-defined causes were more frequent on the original certificates and on the certificates for all deaths than they were on the special certificates.

These findings suggest that in tabulations of fetal deaths by cause there is a tendency to underestimate the importance of maternal conditions as a primary factor in fetal loss.

Neonatal Deaths

For neonatal deaths, agreement between the special and original certificates was observed in

only 27, or 35 percent, of the 77 cases studied (table 3). One of the major reasons for this relatively low percentage agreement, however, is that the rubric hyalinelike membrane (code 527) was not used in 1953 when the original certificates were coded. If the 18 special certificates that give this cause are omitted, the percentage agreement becomes 46 (27 of 59 deaths).

It is interesting that of the 18 deaths ascribed to hyalinelike membrane on the special certificates, 9 were originally attributed to postnatal asphyxia and atelectasis, a cause which at the time was reasonable for deaths that might now be listed as due to hyalinelike membrane. Of the other 9 deaths due to hyalinelike membrane, 4 were originally ascribed to birth injury, 4 to immaturity, and 1 to "all other causes."

Of the causes of neonatal death, there were only two in which the percentage agreement between the special and original certificates was relatively high. These were congenital malformations and hemolytic and hemorrhagic disease of the newborn. In the rubric birth injury, only 5 of the 14 special certificates were matched by the original certificates: 5 were originally ascribed to postnatal asphyxia and atelectasis and 4 to immaturity. Of the 7 deaths assigned to asphyxia and atelectasis on the special certificates, 4 were matched and 3 were originally listed as due to immaturity. Not quite one-half of the deaths attributed to infection of the newborn on the special certificates were similarly designated on the original records; 6 of the 16 deaths from this cause were reported as due to immaturity. Immaturity did not appear as a cause of death on the special certificates.

Although the supporting data are not shown in table 3, it was observed that the percentage agreement between the special and original certificates was markedly different for mature and premature infants. In the group of 58 infants whose birthweight was less than 2,500 gm., matching causes were found on only 11 sets of certificates, or 19 percent. For infants whose birthweight was 2,500 gm. or more, on the other hand, there was agreement for 14 of the 19 cases, or 74 percent. Part of this difference is associated with the fact that hyalinelike membrane was given as the cause of death for more than one-half of the premature infants.

A comparison of the causes for the neonatal deaths in the study with the causes for all neonatal deaths reported among Baltimore City residents in 1953 is shown in table 4. Postnatal asphyxia and infection of the newborn were found more frequently as causes of neonatal death among the original certificates for the study group than among all the certificates for 1953. Deaths due to immaturity were found less frequently among the original study certificates.

Table 3. Comparison of the causes of neonatal death given on special and original death certificates, Baltimore City, Md., 1953

Cause of death according to special certificate [1]	Total	Cause of death according to original certificate							
		A [2]	B	C	D	E	F	G	H
Total	77	...	9	10	23	8	2	21	4
Total excluding deaths due to hyalinelike membrane	59	...	9	6	14	8	2	17	3
A. Hyalinelike membrane (527)	18	...	...	4	9	...	...	4	1
B. Congenital malformations (750–759)	10	...	8	...	1	...	1	...	...
C. Birth injury (760–761)	14	...	...	5	5	...	...	4	...
D. Postnatal asphyxia and atelectasis (762)	7	...	...	...	4	...	...	3	...
E. Infection of newborn (763–768)	16	...	...	1	1	7	...	6	1
F. Hemolytic and hemorrhagic disease of newborn (770–771)	1	...	...	...	...	...	1	...	...
G. Immaturity (774, 776)	...	...	...	...	...	...	...	...	...
H. All other causes	11	...	1	...	3	1	...	4	2

[1] Numbers in parentheses are international statistical classification code numbers.
[2] Hyalinelike membrane was not used when original certificates were filled out.

Table 4. Number and percentage of neonatal deaths, by cause for study deaths and all deaths,[1] Baltimore City, Md., 1953

Cause of death [2]	Number			Percent		
	Study		Baltimore City	Study		Baltimore City
	Special certificate	Original certificate		Special certificate	Original certificate	
All causes	77	77	449	100.0	100.0	100.0
Hyalinelike membrane (527)	18	0	0	23.4	0	0
Congenital malformations (750–759)	10	8	41	13.0	10.4	9.1
Birth injury (760–761)	14	11	69	18.2	14.3	15.4
Postnatal asphyxia and atelectasis (762)	7	23	96	9.1	29.8	21.4
Infection of newborn (763–768)	16	8	20	20.8	10.4	4.5
Hemolytic and hemorrhagic disease of newborn (770–771)	1	2	9	1.3	2.6	2.0
Immaturity (774, 776)	0	20	191	0	26.0	42.5
All other causes	11	5	23	14.2	6.5	5.1

[1] Resident deaths during the first week of life.
[2] Numbers in parentheses are international statistical classification code numbers.

Although use of the rubric hyalinelike membrane on the special certificates makes it difficult to compare these with the other two sets, two features of the data are discernible. First, infection of the newborn was found more frequently on the special certificates than on the original certificates for the study group or on all the 1953 certificates: The percentages are 20.8, 10.4, and 4.5, respectively. Second, immaturity, which was not given as a cause of neonatal death on the special certificates, appeared on a relatively large percentage of the original certificates and on an even larger percentage of all certificates.

Discussion

In this study the causes of death reported on about 40 percent of the original fetal death certificates failed to match the causes given on special certificates. For neonatal deaths not attributed to hyalinelike membrane, about 56 percent of the original certificates gave a cause of death that did not agree with the cause posted to special certificates. These estimates relate to the experience of only one hospital, but there is evidence that the deaths studied represent the total experience of the city reasonably well. Thus, the implication is that inaccuracies of the same magnitude exist in the tabulations of citywide perinatal deaths by cause.

One might speculate about how much death certificate data are affected by inaccurate or incomplete reports of clinical findings, by different interpretations of accurately reported findings, by the zeal of those filling out the certificates, or by differences that arise when coders transform a written diagnosis into the symbols used to prepare punchcards for statistical analysis. But a study as limited as this one cannot identify or appraise such factors precisely.

The indication that inaccuracies exist is not in itself particularly valuable information. What is of more interest to both producers and consumers of death certificate data is the nature of the inaccuracies and the practical measures that can be taken to prevent them.

With regard to the first point, this study indicates that fetal deaths due to causes and conditions in the mother actually occur about twice as often as is shown on death certificates. For neonatal deaths, the data suggest that, apart from deaths due to hyalinelike membrane, infection of the newborn is the most frequently under-reported cause of death.

With regard to the measures that can be taken to improve the quality of death certificate information, it is necessary to keep in mind the

nature of the inaccuracies and to note the characteristics of the special and original certificates that might have a bearing on the inaccuracies. Recall that the physician preparing the special certificate had at hand the clinical history, a detailed report of pathology, and the results of an infant mortality conference. Moreover, he was aware that a test of accuracy was in progress. Contrast this situation with that which probably existed at the time the original certificate was completed. The clinical history was available on request, but only gross findings of the autopsy, if any at all, could be obtained. In addition, the physician completing the original certificate was not under test conditions, although he did know that his report would be made part of a clinical history which would be reviewed at an infant mortality conference.

These considerations indicate that inaccuracies in the original certificates could have arisen as follows: For fetal deaths, although pathological data could have been used to eliminate several possible causes, it seems likely that inaccuracies involving causes in the mother can be attributed to inadequate study of the available information. For neonatal deaths, where under-reporting of infection of the newborn was the most striking finding, a stronger case can be made for the necessity of having pathological data. This is certainly true if hyalinelike membrane is to be used in a meaningful way as a cause of neonatal death.

Thus, this study suggests that the quality of death-certificate data for perinatal deaths could be improved by a more intensive study of available clinical records and by the use of pathological data, especially in assigning causes of death during the neonatal period of life. The first of these recommendations might be implemented by holding periodic conferences with resident obstetrical staff, preferably timed to coincide with the beginning of the term of a new residency, and by making frequent checks of the completeness of fetal and neonatal death certificates. The second could be supported by querying the certifying physician or the hospital in all cases in which there is an indication that an autopsy has been performed.

Summary

A study of 50 fetal and 77 neonatal death certificates submitted to the Baltimore City Health Department by the Johns Hopkins Hospital during 1953 found that some 40 to 50 percent of the cause-of-death statements did not agree with those posted to special certificates based on careful examination of the clinical history, a detailed pathological report, and the findings of an infant mortality conference. The study indicates that deaths due to maternal conditions and causes are under-reported among fetal deaths and that deaths due to infection of the newborn are under-reported among neonatal deaths.

Consideration of the nature of the inaccuracies in conjunction with the conditions under which the original and special certificates were prepared suggests that the quality of death certificate information about perinatal deaths might be improved by a more intensive study of the clinical data and by use of autopsy findings.

Evaluation of the Suessenguth-Kline Test for Trichinosis

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TRICHINOSIS affects an estimated 16 percent of the population of the United States, according to examinations of muscle tissue for trichinae larvae (*1*). The majority of infections are subclinical, but even those with clinical symptoms frequently escape recognition. The high prevalence, the manner of transmission, the frequent severity, and occasional fatal outcome of the disease make trichinosis a matter of public health concern.

Clinical diagnosis of this disease is difficult (*2*). Some laboratory examinations are helpful only if positive, while others show conflicting results (*1, 3–5*). A simple and rapid flocculation slide test for the disease was reported by Suessenguth and Kline (*6*) and subsequently improved (*7*). Because of encouraging results in the previous studies, it was decided to determine the value of the test for public health and diagnostic laboratory purposes. The test was studied for simplicity of performance, for reproducibility, for sensitivity and specificity, and in comparison with one other immunological method of testing.

Simplicity of Performance

It had been found in an earlier study (*6*) that an alkaline aqueous extract of freeze-dried trichinae larvae possesses the property of coating cholesterol crystals so that, when such coated crystals are dispersed in physiological saline, an antigen emulsion is formed. When used in the slide test, the antigen emulsion is sensitive and specific for trichinosis. The freeze-dry method has been found invariably satisfactory for drying larvae. Properly stored larvae used over a period of 9 years showed no loss of sensitivity or specificity when compared with recently prepared larvae.

In performing the test, 0.5 cc. of the serum to be tested is placed on a ringed slide, one capillary drop of the antigen emulsion is added, and the mixture is rotated at 120 r.p.m. for 4 minutes. The paraffin wall of the ring effectively retains the ingredients. Results are read microscopically by the degree of flocculation of the coated crystals. The technique is essentially that of the Kline test for syphilis (*8*).

The test method is simple and rapid. It does not require highly trained personnel for performance. When refrigerated, the antigen emulsion is satisfactory for a period of at least 8 months.

Reproducibility

The reproducibility of the test was determined by examining duplicate portions of 1,216 serum specimens in two different laboratories. The specimens were from suspected trichinosis cases and from random samples of blood sub-

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mitted for routine tests for syphilis. The tests were performed over a period of 3 years; thus, several lots of antigen emulsion were used.

Each serum specimen was tested in both the division of laboratories of the Ohio Department of Health, Columbus, and the department of laboratories, Mt. Sinai Hospital, Cleveland. When quantity of the specimen permitted, the titer of each positive serum also was determined in duplicate.

The results of the study of reproducibility of the test showed excellent agreement (table 1). The duplicate tests of 97.1 percent of the specimens agreed completely (96 positive, 44 weakly positive, and 1,041 negative in both), and 1.1 percent showed partial agreement (positive in one laboratory and weakly positive in the other).

Quantity permitted duplicate titration of 42 positive serums. We considered 38 of these in agreement since they showed no more than a 1-tube difference. The complete results of duplicate titration of these serums were as follows:

	Number of serums
Same titer	23
1-tube difference	15
2-tube difference	4
More than 2-tube difference	0
Total	42

Sensitivity and Specificity

While simplicity of performance and reproducibility of a test are important, sensitivity and specificity are the factors determining its usefulness in medical practice. By questionnaires and investigations of trichinosis epidemics, pertinent clinical and laboratory data were obtained for the evaluation of positive test results (sensitivity) and negative test results (specificity).

Table 1. Comparison of results of duplicate tests for trichinosis on 1,216 serum specimens using the Suessenguth-Kline flocculation slide test

Reactions at Mt. Sinai laboratory	Reactions at Ohio Department of Health laboratory		
	Positive	Weakly positive	Negative
Positive	96	9	2
Weakly positive	4	44	5
Negative	0	15	1,041

The division of laboratories of the Ohio Department of Health tested 306 serum specimens for this portion of the study. These specimens were taken from patients who either showed some clinical symptoms, had presumptive laboratory findings, or were suspected of having trichinosis because they were members of family groups suffering epidemic trichinosis. Of the 306 specimens tested, 108 (35.3 percent) showed some degree of positivity, and 198 (64.7 percent) gave negative test results.

From questionnaires to attending physicians and investigations of epidemics, data were available for analysis of 62 cases for both sensitivity and specificity. The test had shown some degree of positivity for 27 and negative results for 35 of these 62 cases.

Of the 27 cases showing positivity, 25 were diagnosed cases of trichinosis. The 27 cases giving positive results on the test are described below:

	Number positive
Diagnosed as trichinosis	25
Larvae in meat ingested	17
Positive clinical findings and eosinophilia	8
Diagnosed as other than trichinosis	2

One of the two cases not diagnosed as trichinosis was diagnosed as *Strongyloides stercoralis* infection. *S. stercoralis* was found in duodenal drainage; there was an eosinophilia of 50 percent; and the flocculation slide test was weakly positive. This was probably a nonspecific, weakly positive reaction. The other case not diagnosed as trichinosis was given a final diagnosis of "chronic brain syndrome associated with convulsive disorder," although the diagnosis is questionable considering the history and laboratory findings. The patient was a cook and had had trichinosis in 1946; the eosinophil count was 1.2 percent; a skin test for trichinosis was positive; and a complement fixation test was negative. In this case the reaction may or may not have been nonspecific.

None of the 35 cases which had shown nega-

Table 2. Comparison of results of testing 122 [1] serum specimens for trichinosis by both S-K flocculation slide and complement fixation methods

Reactions to S-K flocculation slide test	Reactions to complement fixation test		
	Positive	Weakly positive	Negative
Positive	14	0	21
Weakly positive	1	0	6
Negative	1	0	72

[1] 7 specimens were anticomplementary in the complement fixation test. 2 of these were negative in the slide test, 1 was doubtful, and 4 were positive.

tive test results was diagnosed as trichinosis. In two of these cases there had been exposure to trichinous meat, but clinical symptoms were not found. Pertinent data on these cases are summarized below:

	Number of cases
Muscle pains	11
Vague or positive clinical findings	10
Eosinophilia	5
Had trichinosis 3–10 years before	3
Mental symptoms	2
Other parasitic infection (1 *Leptospira*; 1 *Taenia saginata*)	2
Exposed to trichinous meat; negative clinically	2
Total	35

Although the number of suspected cases on which data were available for analysis was not large, results of this analysis corroborate the high degree of sensitivity and specificity previously reported (*6*) for the S-K flocculation slide test for trichinosis.

Comparison With CF Test

To compare results of the S-K flocculation slide test with those of another immunological test method, 122 specimens were examined by both the flocculation slide and the complement fixation tests. Portions of the specimens were sent to the Communicable Disease Center, Public Health Service, for the complement fixation tests.

Results of the two tests are compared in table 2. Seven specimens were anticomplementary by the complement fixation technique; 87 (71.4 percent) showed complete or partial agreement; and 28 specimens (22.9 percent) showed complete or partial disagreement.

Since disagreement was largely between positive or weakly positive reactions in the slide test and negative reactions in the complement fixation test, it was decided to determine whether test reactions were specific or nonspecific by examining case histories.

Case histories of 57 patients, accounting for 78 of the 122 specimens (for some cases more than one specimen was examined), were available for study. Table 3 compares test results for these 57 cases by type of case as determined by the diagnoses reported in the case histories.

Both tests gave negative results for 30 of the 31 cases diagnosed as diseases other than trichinosis; the remaining case was negative by flocculation slide and anticomplementary by complement fixation. The other 26 of the 57 were cases of diagnosed trichinosis—6 sporadic and 20 epidemic. Of these 26 trichinosis cases, 11 were positive and 2 were negative in both tests, 2 were positive in the slide test and anticomplementary in the complement fixation test, and 11 were positive in the slide test but negative in the complement fixation test.

Table 3. Comparison of reactions to S-K flocculation slide and complement fixation tests for trichinosis of serum specimens representing 57 clinically diagnosed cases

Type of case and reaction to S-K flocculation slide test	Reaction to complement fixation test		
	Positive	Negative	Anticomplementary
Other than trichinosis (31):			
Positive	0	0	0
Negative	0	30	1
Trichinosis—sporadic (6):			
Positive	3	2	1
Negative	0	0	0
Trichinosis—epidemic (20):			
Positive	[1] 8	[2] 9	1
Negative	0	2	0

[1] Specimens from 4 cases were negative 1 month and positive subsequently on the complement fixation test.
[2] Specimens from 2 cases were negative 1 month and positive subsequently on the flocculation slide test.

On the basis of this comparison of test results with case data, it may be concluded that the S-K flocculation slide test is more sensitive for trichinosis than the complement fixation test. An additional advantage of this flocculation slide test is the absence of anticomplementary reactions.

Further studies of the S-K test and its antigen are in order, together with additional comparison with complement fixation tests and also with a recently described flocculation test (*9*) utilizing bentonite particles.

Summary

Because of frequent difficulty in clinical and laboratory diagnosis of trichinosis, there is need for a simple, rapid, and reliable diagnostic test for the disease. The Suessenguth-Kline flocculation slide test for trichinosis is simple and rapid. An antigen emulsion made of cholesterol crystals coated with an alkaline extract of lyophilized trichinae larvae is mixed on a slide with the serum to be tested and rotated for 4 minutes. The result is read microscopically by the degree of flocculation of the coated crystals.

The reproducibility of the flocculation slide test was shown by the 97.1 percent complete agreement and 1.1 percent partial agreement of the results obtained in two laboratories where duplicate tests were performed on 1,216 serum specimens.

An analysis of 62 cases showed the test to have a high degree of sensitivity and specificity. Of 27 positive test results, 25 were for cases diagnosed as trichinosis; for 1 of the other 2 cases, the diagnosis can be regarded as inconclusive. Of 35 negative test results, none were for cases diagnosed as trichinosis; although there had been definite exposure to trichinous meat in 2 cases, no clinical symptoms of the disease were evident.

In a comparison of the S-K flocculation slide test with the complement fixation test, the flocculation slide test showed greater sensitivity. It gave positive results for 11 diagnosed cases of trichinosis for which the complement fixation method gave negative results.

REFERENCES

(*1*) Gould, S. E.: Trichinosis. Springfield, Ill., Charles C. Thomas Co., 1945, pp. 53–143.

(*2*) Kaufman, R. E.: Trichiniasis: Clinical considerations. Ann. Int. Med. 13: 1431–1460 (1940).

(*3*) McNaught, J. B.: Laboratory procedures for the diagnosis of trichinosis. Am. J. Clin. Path. 14: 87–91 (1944).

(*4*) Culbertson, J. T.: Immunity against animal parasites. New York, N. Y., Columbia University Press, 1941, p. 244.

(*5*) Frisch, A. W., Whims, C. B., and Oppenheim, J. M.: Complement fixation and precipitin tests in trichinosis. Am. J. Clin. Path. 17: 24–28 (1947).

(*6*) Suessenguth, H., and Kline, B. S.: A simple rapid flocculation slide test for trichinosis in man and in swine. Am. J. Clin. Path. 14: 471–484 (1944).

(*7*) Suessenguth, H.: Improved antigen for the slide test for trichinosis. Am. J. M. Technol. 13: 213–244 (1947).

(*8*) Kline, B. S.: Microscopic slide precipitation tests for the diagnosis and exclusion of syphilis. J. Lab. & Clin. Med. 16: 186–190 (1930).

(*9*) Bozicevich, J., Tobie, J. E., Thomas, E. H., Hoyem, H. M., and Ward, S. B.: A rapid flocculation test for the diagnosis of trichinosis. Pub. Health Rep. 66: 806–814, June 22, 1951.

Milk Sanitation Honor Roll for 1955–57

Eighty-five communities have been added to the Public Health Service milk sanitation "honor roll," and 53 communities on the previous list have been dropped. This revision covers the period from June 1, 1955, to June 30, 1957, and includes a total of 263 cities and 54 counties.

Communities on the honor roll have complied substantially with the various items of sanitation contained in the milk ordinance suggested by the U. S. Public Health Service. The State milk sanitation authorities concerned report this compliance to the Public Health Service. The rating of 90 percent or more, which is necessary for inclusion on the list, is computed from the weighted average of the percentages of compliance. Separate lists are compiled for communities in which all market milk sold is pasteurized, and for those in which both raw milk and pasteurized milk is sold.

The suggested milk ordinance, on which the milk sanitation ratings are based, is now in effect through voluntary adoption in 475 counties and 1,397 municipalities. The ordinance also serves as the basis for the regulations of 34 States and 2 Territories. In 12 States and the 2 Territories it is in effect statewide.

The ratings do not represent a complete measure of safety, but they do indicate how closely a community's milk supply conforms with the standards for grade A milk as stated in the suggested ordinance. High-grade pasteurized milk is safer than high-grade raw milk because of the added protection of pasteurization. The second list, therefore, shows the percentage of pasteurized milk sold in a community which also permits the sale of raw milk.

Although semiannual publication of the list is intended to encourage communities operating under the suggested ordinance to attain and maintain a high level of enforcement of its provisions, no comparison is intended with communities operating under other milk ordinances. Some communities might be deserving of inclusion, but they cannot be listed because no arrangements have been made for determination of their ratings by the State milk sanitation authority concerned. In other cases, the ratings which were submitted have lapsed because they were more than 2 years old. Still other communities, some of which may have high-grade milk supplies, have indicated no desire for rating or inclusion on this list.

This compilation is from the Division of Sanitary Engineering Services of the Bureau of State Services, Public Health Service. The previous listing was published in Public Health Reports, March 1957, pp. 275–278. The rating method was described in Public Health Reports 53: 1386 (1938). Reprint No. 1970.

The rules for inclusion of a community on the "honor roll" are:

1. All ratings must be determined by the State milk sanitation authority in accordance with the Public Health Service rating method, which is based upon the grade A pasteurized milk and the grade A raw milk requirements of the Public Health Service milk ordinance. (A departure from the method described consists of computing the pasteurized milk rating by weighting the pasteurization plant rating twice that of the raw milk intended for pasteurization.)

2. No community will be included on the list unless both its pasteurized milk and its retail raw milk ratings are 90 percent or more. Communities in which only raw milk is sold will be included if the retail raw milk rating is 90 percent or more.

3. The rating used will be the latest submitted to the Public Health Service, but no rating will be used which is more than 2 years old. (In order to promote continuous rigid enforcement rather than occasional "cleanup campaigns," it is suggested that, when the rating of a community on the list falls below 90 percent, no resurvey be made for at least 6 months. This will result in the removal of the community from the subsequent semiannual list.)

4. No community will be included on the list whose milk supply is not under an established program of official routine inspection and laboratory control provided by itself, the county, a milk control district, or the State. (In the absence of such an official program, there can be no assurance that only milk from sources rating 90 percent or more will be used continuously.)

5. The Public Health Service will make occasional check surveys of cities for which ratings of 90 percent or more have been reported by the State. (If the check rating is less than 90 percent, but not less than 85, the city will be removed from the 90-percent list after 6 months unless a resurvey submitted by the State during this probationary period shows a rating of 90 percent or more. If the check rating is less than 85 percent, the city will be removed from the list immediately. If the check rating is 90 percent or more, the city will be retained on the list for 2 years from the date of the check survey, unless a subsequent rating during this period warrants its removal.)

Communities awarded milk sanitation ratings of 90 percent or more, July 1955–June 1957

100 PERCENT MARKET MILK PASTEURIZED

Community	Date of rating
Arizona	
Graham County	10–16–1956
Phoenix	2 1957
Colorado	
Boulder County	12–14–1956
Colorado Springs	1–19–1956
Denver	10–28–1955
Pueblo County	2– 2–1956
District of Columbia	
Washington	3–12–1956
Georgia	
Albany	5–24–1956
Athens-Clarke County	4– 2–1957
Atlanta	10–28–1955
Augusta-Richmond County	11– 9–1956
Bainbridge	1–19–1956
Baxley	8–14–1956
Calhoun, Gordon County	9– 7–1956
Camilla	9– 9–1955
Cartersville	1–30–1957
Columbus	1–18–1957
Dalton, Whitfield County	9– 9–1955
Douglas	6–14–1956
La Grange	12–20–1956
Moultrie	5–22–1957
Quitman	5– 8–1957
Savannah, Chatham County	9–25–1956
Statesboro-Bulloch County	3–27–1957
Valdosta	4–18–1956
Waycross	8–30–1956
Idaho	
Idaho Falls	6–13–1956
Illinois	
Evanston	3–13–1957
North Shore municipalities	3–20–1957
Glencoe	
Highland Park	
Kenilworth	
Lake Bluff	
Lake Forest	
Northbrook	
Wilmette	
Winnetka	
Oak Park	3– 6–1957
Indiana	
Berne, Bluffton, Warren area	1–17–1957
Brazil	12–21–1955
Elkhart, Goshen, Nappanee area	1–11–1956
Evansville	12–20–1956
Greencastle	1– 4–1956
Indianapolis-Marion County	8–13–1956
Kokomo	2–19–1957
Lafayette	9– 7–1956
La Porte	5–25–1956
Madison	8 1955
Monticello	12– 6–1955
Muncie	11–30–1956
Rochester	12–19–1956
Salem	6–28–1956
South Bend	3– 8–1956
Warsaw	11–16–1956
Kentucky	
Anderson County	5–17–1956
Barbourville	11–28–1956
Bardstown-Nelson County	5–21–1957
Benton	6– 7–1956
Bowling Green	11–17–1955
Brandenburg	4–11–1957
Breckenridge County	5–31–1956
Cadiz	10– 5–1956
Campbellsville	4– 5–1957
Covington	6–13–1957
Eddyville	6– 5–1956
Falmouth	4–26–1956
Frankfort	7–23–1955
Fulton	12–23–1955
Georgetown	10–16–1956
Greenville	6– 6–1956
Hardinsburg	5–31–1956
Harrodsburg	2–20–1957
Hodgensville	2–14–1957
Hopkinsville	11–17–1955
Lawrenceburg	5–17–1956
Liberty	10–11–1956
Louisville-Jefferson County	4–19–1956
Mayfield	9–16–1955
Monticello	7–20–1956
Morgantown	6– 5–1956
Murray	3–16–1956
Newport-Campbell County	10–20–1955
Kentucky—Con.	
Owensboro	5–17–1956
Paducah	8– 5–1955
Paris-Bourbon County	5– 3–1956
Princeton	2–21–1957
Russellville	11– 7–1956
Smithland	6– 6–1956
Spencer County	6– 1–1956
Stanford	12– 2–1955
Trigg County	10– 5–1956
Union County	5– 7–1956
Mississippi	
Canton	11–14–1956
Clarksdale	1– 9–1957
Columbus	9–19–1956
Eupora	2–23–1956
Greenwood	4–25–1956
Grenada	11–15–1955
Hernando	1– 7–1957
Iuka	7–19–1955
Kosciusko	8–10–1955
Laurel	7–12–1956
Louisville	11–23–1956
McComb	8– 2–1956
Meadville	3– 7–1957
Meridian	6–18–1956
Morton	7–24–1956
New Albany	1–18–1956
Oxford	12–14–1955
Picayune	11– 4–1955
Starkville	3–13–1957
State College	3–13–1957
Tupelo	4– 9–1957
Missouri	
Cape Girardeau	7–12–1956
Chillicothe	3– 5–1957
Fulton	3– 7–1956
Kansas City	8–17–1956
St. Louis	11–28–1955
St. Louis County	3–28–1956
Springfield	10–26–1956
Nevada	
Clark, Lincoln, and Nye Counties	5– 1–1957
Yerington	11–21–1955
New Mexico	
Albuquerque	10–26–1956
Portales	9–28–1956

Communities awarded milk sanitation ratings of 90 percent or more, July 1955–June 1957—Con.

100 PER CENT MARKET MILK PASTEURIZED

Community	Date of rating
North Carolina	
Camden County	7- 5-1956
Charlotte	5- 7-1956
Chowan County	7- 5-1956
Craven County	1-20-1956
Cumberland County	3-16-1956
Durham County	8- 7-1956
Edgecombe County	10- 5-1956
Forsyth County	2-22-1957
Guilford County	9-26-1956
Halifax County	2-16-1956
Jackson County	12-12-1956
Lee County	3- 7-1957
Lenoir County	2- 4-1957
Macon County	12-12-1956
Montgomery County	10-22-1956
Nash County	1-17-1957
New Hanover County	5-24-1956
Northampton County	9- 6-1956
Pasquotank County	7- 5-1956
Perquimans County	7- 5-1956
Sampson County	8-27-1956
Scotland County	5-30-1956
Swain County	12-12-1956
Tyrrell County	8- 5-1955
Washington County	8- 5-1955
Wilson County	10-18-1955
Oklahoma	
Ardmore	4-13-1956
Bartlesville	2-26-1957
Guthrie	5-22-1956
Mangum	10-27-1955
Okmulgee	5- 8-1956
Sulphur	2- 9-1956
Tahlequah	5- 1-1956
Tulsa	5-23-1956
Tennessee	
Bristol	11- 3-1955
Chattanooga	11-20-1956
Clinton	5-29-1956
Columbia	6- 7-1956
Cookeville	9-21-1955
Dyersburg	11-14-1956
Fayetteville	6- 7-1956
Franklin	5- 3-1956
Greeneville	6-19-1956
Humboldt	6-19-1956
Huntingdon	10-29-1956
Jackson	6-20-1956
Jefferson City	8-20-1956
Kingsport	11- 9-1955
Knoxville	8-26-1955
Lewisburg	11-21-1955
Livingston	6- 8-1956
Loudon	5-24-1956
Manchester	10-12-1956
Milan	6-19-1956
Morristown	8-20-1956
Murfreesboro	7-14-1955
Nashville-Davidson County	10-27-1955
Newbern	11-14-1956
Paris	11-17-1956
Pulaski	9- 1-1955
Rogersville	11- 7-1955
Shelbyville	5-17-1956
Sparta	5-16-1956
Springfield	7-23-1955
Sweetwater	11-27-1956
Tullahoma	10- 9-1956
Texas	
Burkburnett	8-16-1955
Cleburne	3-13-1956
Corpus Christi	7-26-1955
Dallas	10-19-1956
Edinburg	11-21-1955
El Paso	10-25-1955
Falfurrias	6-22-1956
Gladewater	2-19-1957
Harlingen	6-14-1956
Houston	5-24-1956
Jacksonville	6- 7-1956
Kilgore	2-19-1957
New Braunfels	1-31-1957
Plainview	6- 2-1956
San Benito	6-14-1956
Texarkana	3- 9-1956
Tyler	3- 5-1957
Vernon	10-26-1955
Wichita Falls	2-19-1957
Utah	
Logan	5- 4-1956
Ogden	10-18-1955
Salt Lake City	2-10-1956
Virginia	
Blacksburg	8-16-1956
Bristol	11- 3-1955
Buena Vista	10-28-1955
Christiansburg	8-16-1956
Front Royal	11-10-1955
Glasgow	10-28-1955
Lexington	10-28-1955
Luray	11-11-1955
Marion	11-29-1956
Norfolk	6- 1-1956
Portsmouth	3- 7-1957
Pulaski	8-17-1956
Radford	8-15-1956
Richmond	4- 6-1956
Roanoke	6-1956
South Boston	4-13-1956
Staunton	7-10-1956
Williamsburg	10-25-1955
Washington	
Spokane	10-24-1956
Whitman County	11- 8-1956
Wisconsin	
Appleton	1-10-1957
Ashland	10-10-1956
Baraboo	10-18-1955
Beaver Dam	2- 6-1957
Beloit	12-20-1955
Burlington	10-24-1956
Delavan	10-24-1956
Dodgeville	5-21-1956
Eau Claire	2 -7-1957
Elkhorn	10-24-1956
Fontana	10-24-1956
Fort Atkinson	10-24-1956
Green Bay	10- 6-1955
Janesville	11-23-1955
Kenosha	7-14-1955
La Crosse	1-29-1957
Lake Geneva	10-24-1956
Madison	11-18-1955
Manitowoc	4-12-1957
Milwaukee	6- 8-1956
Oshkosh	7-11-1956
Racine	7-12-1956
Ripon	2- 6-1957
Sheboygan	7- 7-1955
Walworth	10-24-1956
Waupun	2- 6-1957
Williams Bay	10-24-1956

Communities awarded milk sanitation ratings of 90 percent or more, July 1955–June 1957—Con.

BOTH RAW AND PASTEURIZED MARKET MILK

Community and percent of milk pasteurized	*Date of rating*
Georgia	
Marietta, 97.8	10–26–1956
Newman, 95	5– 3–1956
Pelham, 94	9– 7–1955
Thomaston, 91.5	5– 3–1956
Washington, 99.8	3– 1–1957
Winder, 99	3– 7–1957
Idaho	
Ada County, 96	1–11–1957
Kentucky	
Lexington-Fayette County, 99	9–13–1956
Madisonville, 99	1–25–1957
Somerset, 95	1–10–1957
Missouri	
Joplin, 97	12–13–1956
Poplar Bluff, 97.4	8–18–1955
North Carolina	
Cleveland County, 89.9	9–10–1956
Oklahoma	
Elk City, 99	4–30–1956
Henryetta, 80.7	4–17–1956
Lawton, 99.2	12–20–1955
McAlester, 84	7–18–1956
Muskogee, 97.6	12–15–1955
Norman, 99	1–16–1956
Oklahoma City, 98	11– 9–1956
Ponca City, 96.6	4–18–1956
Shawnee, 98.8	11–18–1955
Oregon	
Portland, 99.4	7–30–1955
Tennessee	
Harriman, 96.2	12– 7–1955
Kingston, 87.1	11–21–1955
McMinnville, 98.3	5–15–1956
Texas	
Austin, 99.4	1–28–1957
Brenham, 94	6–13–1956
Brownsville, 98.3	6–28–1956
Fort Worth, 99.98	2–29–1956
Longview, 99	2–20–1957
Lubbock, 99.4	6–14–1956
Marshall, 98	1– 4–1957
McAllen, 99.2	11–21–1955
Mercedes, 99	11–21–1955
Paris, 99	1–23–1957
San Angelo, 99.7	9– 1–1955
Waco, 99.76	3–19–1956
Virginia	
Charlottesville, 99.4	10–17–1955
West Virginia	
Kanawha County, 99	11–20–1956

NOTE: In these communities the pasteurized market milk shows a 90 percent or more compliance with the grade A pasteurized milk requirements, and the raw market milk shows a 90 percent or more compliance with the grade A raw milk requirements, of the milk ordinance suggested by the United States Public Health Service.

Note particularly the percentage of the milk pasteurized in the various communities listed. This percentage is an important factor to consider in estimating the safety of a city's milk supply. All milk should be pasteurized, either commercially or at home, before it is consumed.

Course in Laboratory Diagnosis of Tuberculosis

A course in laboratory methods in the diagnosis of tuberculosis will be offered January 20–31, 1958, by the Public Health Service under the joint sponsorship of the Division of Special Health Services and the Bacteriology Laboratory, Communicable Disease Center, Chamblee, Ga.

Eligible for the course are all grades of employed laboratory personnel who are approved by their State health officers. Personnel attending this course will be offered a student extension service for 1 year after the end of the course.

The course offers practical laboratory training in all phases of tuberculosis bacteriology, microscopy, cultural procedures, diagnostic use of animals, and testing of drug sensitivity.

No tuition or laboratory fees are charged. Reservations should be made well in advance. Information and application forms may be obtained from the Laboratory Branch, Communicable Disease Center, Public Health Service, P. O. Box 185, Chamblee, Ga.

Q Fever and Milk Pasteurization

A SIGNIFICANT number of human cases of Q fever have occurred in the United States in recent years. In certain Western and Southwestern States, the disease has been found to be endemic in cattle, goats, and sheep.

Contaminated milk from animals infected with *Coxiella burnetii*, the organism of Q fever, constitutes one method of introducing the organism into man's environment. Furthermore, early studies of Q fever in California had shown that *C. burnetii* survived the procedures recommended for the pasteurization of milk. Therefore, at the request of the director of the California State Department of Public Health, a cooperative study was organized to determine the times and temperatures required to eliminate viable rickettsiae from a community's milk supply.

The study was conducted in the department of public health, School of Veterinary Medicine, University of California. The Milk and Food Program and the Robert A. Taft Sanitary Engineering Center, both components of the Division of Sanitary Engineering Services, and the Communicable Disease Center were participating agencies of the Public Health Service, and the Dairy Industries Supply Association, Inc., and the Milk Industry Foundation also participated.

Thermal regression lines were constructed from the data obtained in the study and evaluated by statistical methods. For the regression line constructed from the minimum times at each temperature at which no surviving organisms could be demonstrated, a two-sigma or a 97.7 percent confidence interval was calculated. The addition of this confidence interval to the minimum time of destruction regression line was considered to represent an adequate margin of safety and the conclusions reached in the study are based on this method of treating the data.

It was concluded from the results of the study that the minimum recommended standard for the pasteurization of milk of 143° F. for 30 minutes was inadequate to eliminate all the viable rickettsiae from cow's milk. However, heating the milk for 30 minutes at 145° F.

Public Health

MONOGRAPH

No. 47

The accompanying summary covers some of the principal findings presented in Public Health Monograph No. 47, published concurrently with this issue of Public Health Reports. The authors are with the department of public health, School of Veterinary Medicine, University of California, and the Robert A. Taft Sanitary Engineering Center, Public Health Service.

Readers wishing the data in full may purchase copies of the monograph from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. A limited number of free copies are available to official agencies and others directly concerned on specific request to the Public Inquiries Branch of the Public Health Service. Copies will be found also in the libraries of professional schools and of major universities and in selected public libraries.

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Enright, John B., Sadler, Walter W., and Thomas, Robert C.: Thermal inactivation of Coxiella burnetii and its relation to pasteurization of milk. Public Health Monograph No. 47 (PHS Publication No. 517). 30 pages. Illustrated. U. S. Government Printing Office, Washington, D. C., 1957. Price 25 cents.

would accomplish this. Results of the study strongly supported as adequate the minimum recommended standard for the pasteurization of milk at 161° F. for 15 seconds.

A study committee composed of representatives of the Public Health Service and of the milk industry recommended the minimum standards for pasteurization of milk be changed to conform with the findings of the study. The recommendations of this committee were disseminated to State and local milk control authorities and to the dairy industry.

The first part of the study was concerned with the investigation of two vitally important problems. The first was the determination of the maximum number of *C. burnetii* to be found in cow's milk in order to determine the concentration of organisms to be subjected to various temperature-time combinations. This was accomplished by testing milk from various areas of California, by testing the milk of individual cows in a herd in which the infection had existed for some time, by artificially inoculating a lactating dairy cow and testing her milk, and by determining the experience of other Q fever investigators in the United States. This type of field study encompassed many different kinds of husbandry, many different breeds of dairy cows, dairy herds of various epidemiological statuses, and individual animals in different physiological conditions, especially in relation to parturition.

The second problem investigated early in the study was the determination of the best method of detecting the survival of small numbers of *C. burnetii* after the test population had been subjected to various conditions of time and temperature.

It was also determined that no demonstrable difference existed in the thermal resistance of *C. burnetii* when found in the milk of infected cows or when the organisms were grown in embryonating chicken eggs and then added to the milk of normal cows.

In the thermal resistance studies that followed, *C. burnetii* grown in embryonating chicken eggs were added to whole raw milk, adjusted to contain 3.8 percent butterfat, so that the test population of rickettsiae was of the same magnitude as that number found in 100,000 infectious guinea pig doses per milliliter. This test population was subjected to various combinations of time and temperature in both a laboratory study and a study using full-scale commercial pasteurization plant equipment. Tests to determine the presence or absence of surviving organisms consisted of examination of the serums of second-passage guinea pigs for the appearance of specific complement-fixing antibody.

First PHS Grant for Aging Research

An award of $306,922 for research on aging has been granted by the Public Health Service to Duke University, Durham, N. C. The award, announced August 1, 1957, launched the Service's new program to stimulate the establishment of research centers in which university departments and local health and related agencies cooperate in the study of various aspects of aging.

Objectives of the Duke University program are to develop a center for aging research through universitywide effort; to support fundamental research on health problems of aging and to include research contributions from social and behavioral sciences and related fields; to train investigators for such research; and to foster a regional resource for the dissemination of scientific knowledge in the field of aging.

The program of the Public Health Service is under the Center for Research on Aging established in October 1956 at the National Institutes of Health.

U. S. GOVERNMENT PRINTING OFFICE: 1957